

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS.

IN COOPERATION WITH THE UNIVERSITY OF CALIFORNIA AGRICULTURAL
EXPERIMENT STATION.

SOIL SURVEY OF THE VICTORVILLE AREA,
CALIFORNIA.

BY

A. E. KOCHER, OF THE U. S. DEPARTMENT OF AGRICULTURE, IN
CHARGE, AND STANLEY W. COSBY, OF THE UNIVERSITY
OF CALIFORNIA.

[Advance Sheets—Field Operations of the Bureau of Soils, 1921.]



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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[PUBLIC RESOLUTION No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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MAP.

Soil map, Victorville sheet, California.

SOIL SURVEY OF THE VICTORVILLE AREA, CALIFORNIA.

By A. E. KOCHER, of the U. S. Department of Agriculture, in Charge, and STANLEY W. COSBY, of the University of California.

DESCRIPTION OF THE AREA.

The Victorville area is situated in the southwestern part of San Bernardino County. It lies along the southern margin of the arid section of California known as the Mohave Desert and is separated from the less elevated section of southern California by the San Gabriel and San Bernardino Mountains, which form the southern boundary. The east and west boundaries of the area are north and south lines extending across the open desert, the former being drawn at the western base of a series of rugged, stony buttes lying just east of the survey. The southern boundary lies 18 miles north of San Bernardino, and the southwest corner is 48 miles northeast of Los Angeles. Upon the south the Victorville area overlaps a small part of an area included in an earlier survey.¹ The area comprises the upper part of Victor Valley, and has an extent of 354 square miles, or 226,560 acres.

Excepting the mountain foot slopes along the south side, and a few scattering buttes and low rocky ridges, the area in general is smooth. The principal physiographic features are the Mohave River Valley, the east and west mesas, the high alluvial fans and foothills, and the isolated rocky buttes. The east mesa is known as Apple Valley, and a lower part of it, bordering the river bottom, as the First Bench. The upper or southern part of the west mesa above Hesperia and stretching westward along the foothills beyond Cajon Pass is known as Baldy Mesa. The lower and northern part of the west mesa, around the settlement of Adelanto, is called Sunrise Valley.² (See sketch map, fig. 25.)

The area is crossed from south to north by the Mohave River, which is formed by the junction of East Fork, or Deep Creek, and the West Fork at the base of the San Bernardino Mountains. From this point, just outside the south boundary of the area, it extends about 10 miles



FIG. 24.—Sketch map showing location of the Victorville area, California.

¹ Reconnaissance Soil Survey of the Central Southern Area, California, Field Operations, Bureau of Soils, 1917.

² Report on the Utilization of the Mohave River for Irrigation in Victor Valley, California. Bulletin No. 5, State of California, Department of Engineering.

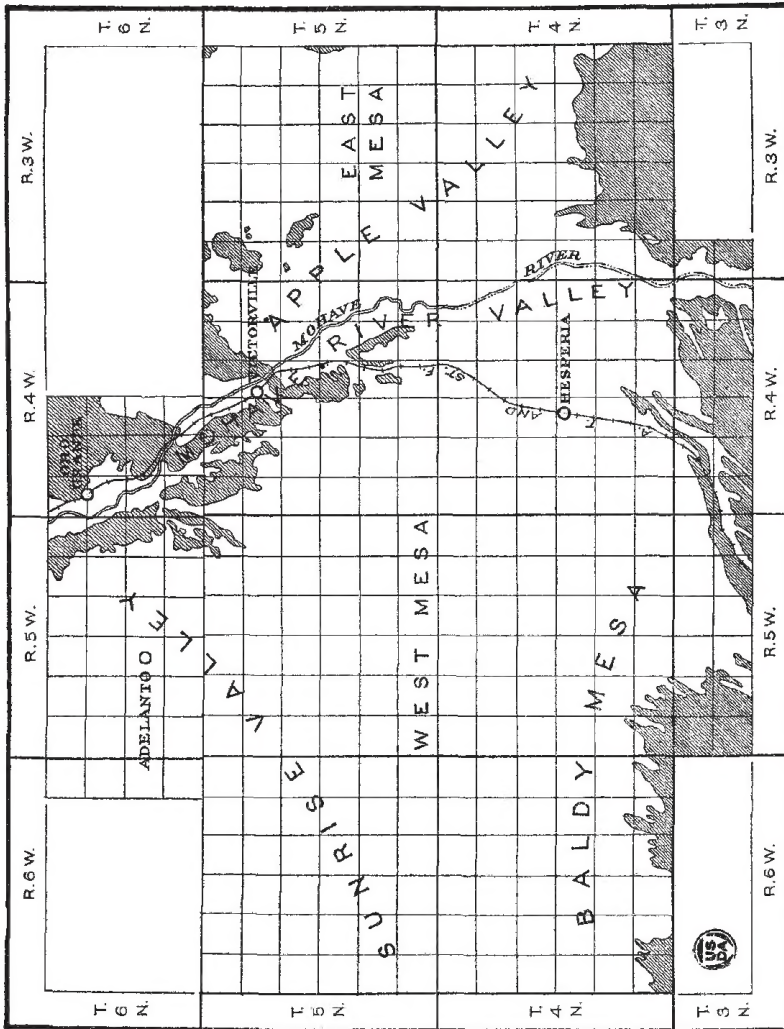


Fig. 25.—Sketch map showing physiographic divisions. Shaded areas represent Rough broken land and Rough stony land.

north to within 4 miles of Victorville, where it bears to the west and continues in a northwesterly direction until it leaves the area. For 90 miles it continues northward across the desert without receiving a surface tributary of importance until finally it is lost in the dry bed of Mohave River Sink, also known as Soda Lake. At Victorville it passes through a granite gorge 140 feet in width, known as the Upper Narrows, and again, $2\frac{1}{2}$ miles below, the valley is similarly constricted at the Lower Narrows. These features are important, since the water is brought to the surface by bedrock in the channel, whereas in other localities it sinks in the porous sands of the channel. Except at the Upper and Lower Narrows, the river valley ranges from one-half mile to 2 miles in width, and lies from 100 to 150 feet below the

adjoining mesas. The valley floor is smooth, and it is economically irrigated from flowing or shallow wells. The upper 5 miles of the east side and practically all of the west side of the stream valley are confined within steep, gravelly bluffs. At Victorville, and from the Lower Narrows north, the valley is bounded on the east by steep, barren areas of Rough stony land, but from Victorville south the lowlands rise eastward in a series of easy slopes gradually merging into a low terrace, the First Bench. This bench, varying from one-fourth to about 1 mile in width, lies from 50 to 100 feet above the river. It has a smooth, gently sloping surface and is favorably situated with respect to drainage and irrigation.

Apple Valley is a smooth, treeless plain lying 100 to 400 feet above the river and 2,900 to 3,200 feet above tide. The central part appears nearly level and contains a number of small flat playas or dry lake beds with no drainage outlets. From these low basins the surface slopes gently upward toward bordering buttes on the north and east and toward the foothills of the San Bernardino Mountains on the south. Excepting a few minor washes on the slopes between the mesa proper and the First Bench, the surface is practically unmarked by drainage courses.

The northern part of the west mesa, or Sunrise Valley, is a smooth, sandy plain sloping gently to the north and separated from the river valley by a belt of rough eroded country. This belt, which varies from one-half mile to about 1 mile in width, consists principally of Rough broken land and is practically valueless for agriculture. Except for a slight billowy effect, due to the presence of wind-blown mounds, the greater part of the plain of Sunrise Valley appears almost level, yet there is a uniform slope of about 50 feet to the mile. On the south it merges into Baldy Mesa with no distinct line of separation.

As one goes south, however, the slope gradually increases, the average rise ranging from about 75 feet to 125 feet to the mile. Drainage courses, which are shallow and noncontinuous on the desert plains, are here well marked and confined within definite banks. Two such stream valleys, the Antelope Valley and the Oro Grande Wash, are deeply intrenched and maintain their identity until they enter the Mohave River Valley. Their valleys range from one-eighth to one-fourth mile in width and occupy positions 50 to 200 feet below the plains adjacent. Their slopes are abrupt and, except in their upper courses, are but little broken by lateral drainage courses. Several other deep washes occur a few miles southeast, south, and west of Hesperia, and because of their steep slopes they render several square miles of land unfit for irrigation. The greater part of Baldy Mesa, however, has a favorable surface for irrigation. The smoothest part is in the vicinity of Hesperia.

Elevations range from about 3,400 feet along the north side to about 4,000 feet at the foothills. Rainfall is somewhat greater on the higher slopes and has given rise to successive zones of vegetation. The lower plains are sparsely covered with desert shrubs consisting principally of greasewood, or creosote bush (*Larrea tridentata*, Coville), hop sage (*Grayia spinosa*), and giant yucca or Joshua tree (*Yucca arborescens*). (Pl. XIX, fig. 1.) As one goes south the creosote bush

gives place to juniper (Pl. XIX, fig. 2), hop sage is replaced by sage, and bunch grass (*Sporobolus*) and other forage plants are of increasing importance. Near the upper margin of the mesa a zone of scrub oak appears, and farther south, but still within the area surveyed, the slopes are densely covered by a growth mainly of chamisal.

High alluvial fans and mountain foothills border the area on the south, and form a belt varying from 1 to 4 miles in width within the area surveyed. Near the southwest corner of the area they range in elevation from 4,000 to 5,000 feet above sea level. Being composed of old water-laid deposits, they are comparatively free from large stones or rock outcrop, but the slopes are steep and deeply eroded and in the main unsuited for cultivation. A few miles southwest of the survey the San Gabriel Mountains culminate in San Antonio Peak or "Old Baldy," elevation 10,080 feet. Near the south boundary, and about 6 miles southwest of the area surveyed, the San Gabriel Mountains are broken by a low divide, the Cajon Pass, beyond which to the east the range is known as the San Bernardino Mountains. About 10 square miles of this mountain range is included in the southeast corner of the survey. It rises within the area to elevations of nearly 5,000 feet, but unlike the foothills of Baldy Mesa it is mountain-like in appearance with slopes steep, rocky, and precipitous. Between the mountain and the smooth plain of Apple Valley lies a belt of rolling foothills and high alluvial fans, ranging from about 1 to 2 miles in width. This section is too steep and broken for irrigation and is only poorly suited to grazing.

Stony buttes, or low mountainous elevations and ridges, occupy several square miles along the north boundary of the area east of the Mohave River, at Victorville, and in the northern central part of Apple Valley. They rise with precipitous slopes 200 to 400 feet above the plains. They consist principally of granite outcrops devoid of vegetation, and are valueless for agriculture. (Pl. XX, fig. 1.)

The entire area is drained by the Mohave River and tributary desert washes. The channel of the Mohave ranges from little more than 100 feet wide at the Upper and Lower Narrows, to nearly one-half mile in its upper course. At the Narrows, and between these points and the north boundary, the water usually flows the year round, but from the Upper Narrows south the water sinks in the broad expanse of sands and is seen only for short periods during the winter months or following occasional periods of heavy freshets. Excepting a small area in the river bottom just above the Upper Narrows, where the water table stands at only a few feet below the surface, and a few small playas, or shallow depressions, in Apple Valley (Pl. XX, fig. 1) the entire area is well drained. There are a few springs in the bluffs along the west side of the river below Victorville, but only one is of importance for irrigation. Several drainage courses extend northward across Baldy Mesa, but they rarely carry water, and most of them are lost in the desert sands before they cross the area.

Among the first settlements in the Victorville area were those made by cattlemen in 1867 in the Mohave River Valley near Victor-

ville.³ By 1874 it is said the first settler had 1,500 acres under fence and a ditch constructed for irrigation. For a number of years cattle were grazed on the open range and pastured on the irrigated lands in the valley. In 1885 the Atchison, Topeka & Santa Fe Railway was completed across the area, giving an added stimulus to settlement. About 1886 Victorville and Hesperia were founded, a number of irrigation projects were instituted, and homesteads began to be taken up at some distance from the river. At the present time about one-third of the area surveyed is State school land, railroad grant lands, patented and unpatented, and holdings in the hands of corporations, or land proved on or applied for under the homestead or desert land acts. Of the lands held by corporations a considerable acreage is developed and under irrigation. Owing to the light rainfall, only a few settlers in the more favored sections were able to make a living and, failing to obtain the expected supply of water for irrigation, many were compelled to abandon their homesteads after completing title to the land. The area is very thinly settled. Of the 455 houses in the area, exclusive of those in the towns, only 126 were found to be inhabited at the time of this survey. Victorville, the largest town, has a population of about 600. Oro Grande, in the northern part of the area, noted for the manufacture of cement, and Hesperia, in the southern part of the area, are small towns. Adelanto is a small fruit-growing settlement in the northern part of Sunrise Valley. The most thickly settled sections are the river valley, including the bench along the east side, and a narrow strip bordering the Hesperia-Palm-dale Road on Baldy Mesa.

Transportation facilities are good. The transcontinental line of the Atchison, Topeka & Santa Fe Railway crosses the area from north to south. At Barstow, 38 miles north of Victorville, the line divides, going east to the principal points in the eastern part of the United States and north to San Francisco. To the south the road leads to San Bernardino and Los Angeles. The Santa Fe tracks are used also by the Union Pacific Railway, which also runs to Los Angeles and to Salt Lake City.

The country road system of the area is adequate for the present distribution of population. A paved highway extends from the Cajon Pass, near the south boundary of the area, to San Bernardino and Los Angeles, but at present there are no hard-surfaced roads within the area. Funds are said to be available, however, for paving the 16-mile gap between Victorville and Cajon Pass, and it is planned to lay this pavement during the present summer (1921). Owing to the arid climate, the earth roads are easily maintained in good condition, although in the more sandy sections it is sometimes necessary to remove loose sand which drifts into the roadway during the period of high spring winds. Telephone service is quite general along the main highways, and schools are conveniently located.

Los Angeles is the principal market for livestock and the small quantity of fruit which has so far been marketed. Victorville and Oro Grande are small local markets for vegetables, poultry, and other produce.

³ Op. cit.

CLIMATE.

The Victorville area, lying on the north side of the San Bernardino and San Gabriel Mountains, although in southern California and within a few miles of the citrus belt of San Bernardino and Riverside, has a climate as different from that section as though it lay in another part of the continent. These mountain ranges, together with the Coast Range Mountains on the west, shut off the moisture-laden winds of the Pacific Ocean and give this section the characteristic climate of elevated deserts of the West. It is exceedingly arid, although toward the mountains the rainfall increases, making possible dry farming in a small way. There is a wide range in temperature. The winters are cold for this latitude, since the greater part of the area lies between elevations of 3,000 and 4,000 feet. During the summer the temperature is high, but owing to the low humidity the heat is not oppressive. There is a large percentage of sunshiny days. Winds are annoying during the winter and spring months, but aside from this the climate in general is healthful and agreeable.

Climatic records have been kept within the area surveyed only during the last few years, but they show that there is considerable variation in rainfall in different parts of the area. The following table, taken from Bulletin No. 5 of the State of California Department of Engineering, gives an incomplete record of rainfall at five stations within the area for the period of 1904 to 1916, inclusive:

Precipitation in the Victorville area, California.

| Season. | Forks, elevation 3,000 feet. | Hesperia, elevation 3,190 feet. | Dobie Ranch, elevation 3,130 feet. | Rancho Verde, elevation 2,760 feet. | Victor- ville, ele- vation 2,726 feet. |
|-------------------|------------------------------------|---------------------------------------|---|--|---|
| | <i>Inches.</i> | <i>Inches.</i> | <i>Inches.</i> | <i>Inches.</i> | <i>Inches.</i> |
| 1904-5 | | 12.42 | | | 6.70 |
| 1905-6 | 14.94 | 4.78 | | 6.71 | 5.89 |
| 1906-7 | 25.77 | 13.44 | | 10.72 | 8.61 |
| 1907-8 | 9.14 | 9.33 | | 6.28 | 5.75 |
| 1908-9 | 9.94 | 5.21 | 3.35 | 5.19 | 4.94 |
| 1909-10 | 17.14 | 8.99 | 2.85 | 6.16 | 4.47 |
| 1910-11 | 11.75 | 8.21 | 3.84 | 5.72 | 3.25 |
| 1911-12 | | | 3.77 | 5.82 | |
| 1912-13 | | | 3.50 | 2.72 | |
| 1913-14 | | | 6.76 | 7.27 | |
| 1914-15 | | | 6.91 | | |
| 1915-16 | | | 3.40 | | |
| Average | 14.78 | 8.91 | 4.30 | 6.29 | 5.66 |
| Number of seasons | 6 | 7 | 8 | 9 | 7 |

From this it will be seen that the rainfall varies considerably even within short distances. The average seasonal rainfall at Victorville in the Mohave Valley is 5.66 inches, while at Rancho Verde within the same valley and only one-half mile distant, but separated from Victorville by a low ridge, it is 6.29 inches. The least average seasonal rainfall recorded, 4.3 inches, is at the Dobie Ranch on the open desert about 15 miles southwest of Victorville. Only meager records are available for other parts of the west mesa, but it is stated

that the rainfall increases with the elevation, a conclusion that is borne out by the increasing vigor of the vegetation as one goes toward the hills. Judging from the character of the vegetation and from the statements of settlers, the rainfall on the east mesa is still less than that on the west mesa. This is undoubtedly due to its more remote position with respect to Cajon Pass, through which most of the moisture-laden clouds enter the desert. It is also interesting to note that the elevations at Dobie Ranch, Hesperia, and The Forks are practically identical, yet Hesperia, which lies nearly opposite the pass in the mountains, receives about twice as much rainfall as Dobie Ranch, while The Forks, which lies in the Mohave Valley at the base of the mountains, receives much more than does Hesperia. From The Forks up the slopes the precipitation increases rapidly, reaching 50 inches or more near the summit. On the other hand, it falls off rapidly across the desert, the average annual rainfall at Barstow, 38 miles north of Victorville, being only 3.62 inches, while in 1904, the driest year, only 0.8 inch was recorded. The following table, covering a period of eight years, gives the average seasonal and monthly distribution of rainfall at the Dobie Ranch:

Monthly precipitation at Dobie Ranch 1908-09 to 1915-16.

| Month. | 1908-9 | 1909-10 | 1910-11 | 1911-12 | 1912-13 | 1913-14 | 1914-15 | 1915-16 | Mean. |
|----------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. |
| July..... | 0 | 0 | 0 | 0 | 0 | 0.30 | 0 | 0 | 0.04 |
| August..... | 0 | 0.90 | 0.05 | 0 | 0 | .13 | 0 | 0 | .13 |
| September..... | 0.40 | 0 | 0 | 1.74 | 1.01 | 0 | 0 | 0 | .39 |
| October..... | .76 | 0 | 0 | .10 | 0 | 0 | 0.36 | 0 | .15 |
| November..... | 0 | .15 | .10 | 0 | .18 | .67 | .22 | 0.10 | .18 |
| December..... | .38 | 1.18 | 1.03 | .15 | 0 | .08 | 2.23 | .22 | .53 |
| January..... | .60 | .32 | 1.38 | 0 | .87 | 3.17 | 1.19 | 2.56 | 1.26 |
| February..... | .20 | 0 | .48 | 0 | 1.26 | 1.03 | 2.18 | .36 | .31 |
| March..... | 1.01 | .30 | .61 | 1.48 | .08 | .06 | .07 | .06 | .46 |
| April..... | 0 | 0 | .18 | .30 | 0 | 1.23 | .40 | 0 | .26 |
| May..... | 0 | 0 | .01 | 0 | 0 | .10 | .26 | .11 | .06 |
| June..... | 0 | 0 | 0 | 0 | .10 | 0 | 0 | 0 | .01 |
| Season..... | 3.35 | 2.85 | 3.84 | 3.77 | 3.50 | 6.76 | 6.91 | 3.40 | 4.27 |

Very little rain falls between April and September, and a large proportion of the total annual precipitation occurs in December to April, inclusive.

Snow falls occasionally in the higher parts of the area and infrequently in the desert, but it rarely covers the ground for more than a few hours at a time.

From the following table it will be seen that the mean annual temperature recorded at Barstow is 64.2° F. The highest is 114 and the lowest 12° F. The average date of the last killing frost in spring is February 24, and the average date of the first killing frost in the fall November 4. Killing frost has occurred, however, as late in the spring as March 23 and as early in the fall as October 19. These figures are not entirely representative of the Victorville area, as Barstow lies at a lower elevation and considerably farther out in the desert. The temperature for all seasons is somewhat higher than in the area surveyed, and the rainfall is somewhat less.

The following table, compiled from records of the United States Weather Bureau, shows the normal monthly, seasonal, and annual temperature and precipitation at Barstow, Calif.:

Normal monthly, seasonal, and annual temperature and precipitation at Barstow.

[Elevation 2,105 feet.]

| Month | Temperature. | | | Precipitation. | | |
|-----------------|--------------|---------------------------|---------------------------|-----------------|---|--|
| | Mean. | Absolute maxi- mum. | Absolute mini- mum. | Mean. | Total amount for the driest year (1904). | Total amount for the wettest year (1918). |
| December | ° F. 46.8 | ° F. 87 | ° F. 14 | Inches. 0.60 | Inches. T. | Inches. 0.50 |
| January | 47.8 | 82 | 12 | .62 | T. | .13 |
| February | 51.7 | 86 | 16 | .49 | 0.30 | .75 |
| Winter | 48.8 | 87 | 12 | 1.71 | .30 | 1.38 |
| March | 57.8 | 94 | 21 | .56 | .10 | 2.18 |
| April | 62.2 | 99 | 30 | .07 | 0 | T. |
| May | 67.8 | 111 | 34 | .04 | 0 | .62 |
| Spring | 62.6 | 111 | 21 | .67 | .10 | 2.80 |
| June | 77.4 | 113 | 40 | .00 | 0 | 2.97 |
| July | 83.4 | 114 | 50 | .12 | .40 | 1.28 |
| August | 82.8 | 112 | 48 | .15 | T. | .06 |
| Summer | 81.2 | 114 | 40 | .27 | .40 | 4.31 |
| September | 74.3 | 111 | 39 | .16 | 0 | 1.48 |
| October | 64.0 | 97 | 27 | .51 | 0 | .78 |
| November | 54.9 | 90 | 14 | .30 | 0 | .24 |
| Fall | 64.4 | 111 | 14 | .97 | 0 | 2.50 |
| Year | 64.2 | 114 | 12 | 3.62 | .80 | 10.99 |

The following table gives the maximum and minimum temperatures at the Dobie Ranch for the period of 1909 to 1916, inclusive:⁴

Temperatures in degrees Fahrenheit at Dobie Ranch.

| Month. | 1909 | | 1910 | | 1911 | | 1912 | | 1913 | | 1914 | | 1915 | | 1916 | |
|-----------------|------|------|------|------|------|------|-------|-------|------|------|------|-------|-------|------|-------|-------|
| | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. |
| January | 70 | 26 | 68 | 12 | 60 | 16 | 68 | 14 | 64 | 12 | 66 | 22 | 58 | 24 | 65 | 18 |
| February | 66 | 26 | 69 | 12 | 53 | 19 | 68 | 18 | 67 | 21 | 64 | 26 | 62 | 28 | 75 | 19 |
| March | 72 | 25 | 84 | 30 | 84 | 24 | 67 | 29 | 85 | 20 | 76 | 30 | 74 | 34 | 88 | 30 |
| April | 89 | 38 | 94 | 34 | 84 | 24 | 78 | 29 | 93 | 32 | 82 | 33 | 86 | 30 | 91 | 39 |
| May | 98 | 40 | 109 | 33 | 86 | 35 | 92 | 38 | 97 | 28 | 97 | 38 | 98 | 40 | 96 | 36 |
| June | 106 | 47 | 105 | 42 | 106 | 42 | 106 | 42 | 100 | 40 | 106 | ..... | 105 | 42 | 109 | 40 |
| July | 111 | 49 | 108 | 46 | 106 | 52 | 108 | 46 | 108 | 50 | 106 | ..... | ..... | 103 | 47 | ..... |
| August | 102 | 52 | 106 | 54 | 107 | 50 | 103 | 50 | 106 | 50 | 110 | ..... | 106 | 61 | ..... | ..... |
| September | 102 | 40 | 100 | 60 | 102 | 43 | 98 | 40 | 98 | 38 | 95 | ..... | 102 | 42 | ..... | ..... |
| October | 83 | 44 | 91 | 34 | 78 | 36 | ..... | ..... | 86 | 28 | 86 | ..... | 94 | 40 | ..... | ..... |
| November | 78 | 30 | 78 | 26 | 74 | 16 | 70 | 30 | 74 | 22 | 72 | 22 | 80 | 18 | ..... | ..... |
| December | 67 | 12 | 68 | 24 | 64 | 14 | 58 | 14 | 60 | 20 | 50 | 16 | 70 | 18 | 66 | 66 |
| Year | 111 | 12 | 109 | 12 | 107 | 14 | 106 | 14 | 108 | 12 | 110 | 16 | 106 | 18 | 109 | 18 |

⁴ Op. cit.

The highest temperature recorded at this station is 111° F. and the lowest is 12° F. It is stated that the temperature at Victorville has fallen below zero on occasions. In general, very little damage should be expected in this area from frosts, as the high altitude retards the development of the fruit buds in the spring until after most of the danger is past.

The Victorville area is a region of much wind. Strong air currents are especially common during the spring months, when they frequently blow from a southwesterly direction for several days at a time. Besides drifting the light-textured soils in roadways and fields, and causing orchard trees to lean strongly to the northeast, they intensify the effect of the dry atmosphere and cause a very high rate of evaporation. According to the Fourth Annual Report of the Los Angeles Board of Water Commissioners, the evaporation from a water surface in this part of the desert from June to December, inclusive, 1908, was 56.4 inches, and it was estimated that the loss for the entire year was 86.55 inches. This high rate, combined with the low annual rainfall, makes irrigation necessary for successful crop production.

AGRICULTURE.

Agriculture in the Victorville area began in the late sixties, when a few stockmen settled along the Mohave River. They located where water was available, either from springs or from the stream, grew a little hay, and ranged their cattle on the adjoining public lands. Some small irrigation ditches are said to have been in use even at this early day.

A few years later a number of private irrigation and colonization enterprises involving several thousand acres were begun in this region. In 1886 the towns of Victorville and Hesperia were founded. This period of settlement was succeeded by a period of general depression caused in part by inadequate water or a complete failure of the supply, together with considerable litigation over water rights, some of these cases still being in the courts for decision.

With continued encroachment by settlers upon the public lands, the stockmen began to find themselves about 1890 with an insufficient area of open grazing land. Some sold out their holdings and others changed to the growing of fruit, alfalfa, and other crops. The high tide of this change occurred during the few years immediately following 1910, when the greatest development in irrigation farming took place.

At present the agriculture of this area consists of the growing of various fruits for sale, alfalfa and grain hay for feed, cattle and dairy products for sale and home use, and a small amount of vegetables for local consumption.

Fruit growing has rapidly become the leading activity, although most of the orchards are less than 10 years old (Pl. XX, fig. 2). While apples are probably the more extensively planted, pears are now generally considered the more profitable crop, and a large proportion of the recent plantings have been of this fruit. No definite figures are available as to acreages or ages of the orchards. The yield from 6-year-old to 8-year-old pear trees is said to be about 1½ tons to the acre. In 1920 the fruit was sold through Los Angeles commission

houses, bringing \$75 a ton. Apples gave a gross return the same year of about half as much, yielding about 1 ton per acre and selling at \$50. A great variety of apples is grown, among them being the Jonathan, Stayman Winesap, Winesap, Black Ben, Yellow Bellflower, Rome Beauty, Baldwin, and Ben Davis. Apparently there is no marked preference among the apples, whereas the Bartlett is practically the only pear planted. A number of other fruits, including peaches, apricots, prunes, and cherries, have recently been planted to a small extent and seem to yield regularly and well.

Irrigation is necessary, the yearly amount of water used upon orchard lands ranging from $1\frac{1}{2}$ to $2\frac{1}{2}$ acre-feet. It is common practice to irrigate every 4 to 6 weeks from May to October; a few of the orchardists give one or two irrigations during the winter. Pruning is usually done in January, and instead of "heading back" the long-pruning method is common. Clean culture is the usual practice, but where the water supply is adequate a cover crop of rye is occasionally grown. Few insect pests and diseases have appeared, but spraying is practiced for the codling moth.

In past years the fruit has either been sold locally or shipped to commission houses in Los Angeles. A growers' association was formed this year (1921), with headquarters in Victorville, for the purpose of storing and marketing the fruit in a more satisfactory way.

A few vineyards have been set out near Adelanto and are doing well. Sultanina (*Thompson Seedless*) is the favorite variety of grape, and while the vines are still very young yields of three-fourths ton per acre have been reported.

A small acreage of alfalfa is planted along the bottom lands of the Mohave River and on the bench land adjoining. One of the larger ranches is reported as having 650 acres in this crop with yields reaching 4 to 6 tons annually. Alfalfa is cut four or five times a season, each cutting being followed by an irrigation. The hay is usually fed on the ranch to the dairy and beef stock, although some is sold to the ranchers on the mesa lands or shipped to Los Angeles. The average price received in 1920 was about \$16 a ton. Some of the growers disk their alfalfa fields in the winter, and sometimes, when badly infested with foxtail, burn them over.

Grain for hay is grown to some extent along the river bottom and to a greater extent in the bottoms of the arroyos throughout the southern part of the area, where the annual rainfall is somewhat greater. Wheat, barley, and a very small amount of rye are sown for hay, with the first-named of most importance.

Cattle raising and dairying are no longer increasing in popularity, primarily because of the reduction in area and quality of the open grazing land. A few animals are brought in from the range regularly and finished on the river-bottom pastures and stubble. They are shipped to Los Angeles for sale. The dairy herds are small and the products sold locally. At the present time there are practically no shipments of dairy products from this region, although as early as 1900 one local dairy is said to have been shipping 500 pounds of butter daily.

Vegetables and similar products are not raised commercially in the area. They do well, however, in the numerous small home gardens. An unsatisfactory attempt was made a few years ago to raise sugar beets.

No systematic rotation of crops is followed in the area. Alfalfa, once planted, occupies the field as long as a satisfactory stand is maintained. Barley is usually planted two or more years on the same land. It may be followed by corn or by other crops, according to the wish of the individual farmer. Little or no fertilizer is used, with the exception of the plowing under of cover crops for green manure, and this practice is restricted by the scarcity of water.

The farmers of the Victorville area recognize that the soils of the Hanford and Foster series are best adapted in this region to the growing of alfalfa. This is possibly due to the location of these soils along the river, where water for irrigation is comparatively abundant, and to the fact that their water-holding capacity is far better than that of the more porous soils of the Cajon series occupying the same relative position. The soils of the Hesperia and Cajon series on the higher slopes in the southwestern part of the area, where the rainfall is appreciably greater, are also recognized as being more favorable for dry farming than the drier, more compact, soils to the northward.

Except on a few of the more prosperous farms and orchards, the farm buildings in this area are cheaply constructed and frequently inadequate. The great majority are only slightly better than are required to "prove-up" on a desert claim. (Pl. XXI, fig. 1.) Many of them are unoccupied and in a dilapidated condition. The fences are usually maintained in a good condition, as they are needed to protect the crops and trees from injury by jack rabbits and range stock. In general, the farm machinery is adequate for the needs, but the work stock consists of small to medium-grade animals. A large proportion of the beef cattle are grade Herefords and Shorthorns.

Sufficient farm labor is available to meet the present demands. It is supplied locally, usually by the farmer's family or by men from the near-by towns. Most of the laborers are white. In 1920-21 the wage of day labor was \$4.

SOILS.

The soil-forming materials of the Victorville area have been transported by water from the surrounding foothills and mountains to their present position. The accumulation of these materials in the part of the desert included in the survey has been vast, the deposits having a maximum depth of several hundred feet. These materials have been washed from areas chiefly of granite with quartz as a prominent constituent. Schist and marble formations are found in the mountain east of Oro Grande, but these have contributed little to the soils of the area. From these unconsolidated deposits through long ages of weathering the principal soils of the area have developed. They are generally light-colored soils, and in places the light color

has been intensified by accumulations of lime. Typically the soils have a pinkish cast, and in certain series they are light red. The granites have disintegrated with incomplete weathering, the soil particles consisting mainly of angular sand and gravel fragments with a comparatively small proportion of silt and clay particles. Being in a region in which high winds are prevalent, much of the finer materials have been blown away, leaving the coarser particles accumulated on the surface. For this reason many of the soils are of heavier or more loamy character than would be indicated by surface appearance.

Excepting the type of nonagricultural miscellaneous material designated as Rough stony land and certain mountainous areas of Rough broken land, which might be classed as residual soils, all the soils of the area are of transported origin. According to age, or stage in development as reflected in color of the materials and character of soil profile, they may be classified into two general groups: (1) Old valley-filling soils, or those derived from unconsolidated water-laid deposits which have been laid down for a considerable length of time, and which have undergone marked physical and chemical changes since their deposition; and (2) recent alluvial soils, or those deposited by water along the streams or on alluvial fans within comparatively recent time, and in which modification in the soil profile through weathering in place is insignificant.

On the basis of differences in color, structure, drainage conditions, origin and mode of formation, and in occurrence or in absence of hardpan or other pronounced zones or horizons in the soil profile, the soils of each of these two major groups are classified further into soil series. Each soil series is represented by one or more soil types, which are distinguished one from another on the basis of difference of texture or the proportion of mineral particles of the various sizes that go to make the type.

Subordinate differences within individual soil types are treated as phases of that type and shown on the map by means of rulings over the type color. Still smaller differences are discussed in this report but not shown on the accompanying map.

It is to be noted that in this survey the soils are classified and mapped in much more detail than in the earlier survey⁵ already referred to, and that soil boundaries as delineated in the two surveys do not always closely agree. This is due in part to the general nature of the earlier survey, in which details were of necessity ignored, and in part to the fact that with advance in knowledge of the soils of the region some of the soil series established in the earlier survey have been changed.

The soils derived from the old valley-filling materials are usually characterized by compact, heavier textured subsoils, a relatively elevated position, well-developed drainage, and a more or less sloping or undulating topography. They are more thoroughly weathered, are in places rather red in color, and on the higher fans are being actively eroded. In several of the soil series the subsoils contain one or more zones of exceedingly compact structure. The first one is commonly found between 12 and 24 inches below the surface, and seems

⁵ Reconnaissance Soil Survey of the Central Southern area, Calif. Field Operations, Bureau of Soils, 1917.



FIG. 1.—VIEW NEAR ADELANTO

Note desert vegetation of yucca, creosote bush, and small shrubs and annuals, and the hummocky wind-blown surface, characteristic of unirrigated Adelanto sand



FIG. 2.—NATIVE VEGETATION OF JUNIPER AND YUCCA (JOSHUA TREE) ON CAJON LOAMY FINE SAND



S. 11173

FIG. 1.—A DESERT SINK OR PLAYA

The soil is the Mohave loam, playa phase. The hills in the distance are buttes mapped
Rough stony land



S. 11497

**FIG. 2.—A 9-YEAR-OLD APPLE ORCHARD ON ADELANTO SAND, SHOWING
USUAL CLEAN CULTIVATION**

to have resulted from the translocation of the silt and clay from the surface to the subsoil where they have been firmly bound to the angular particles through the cementing action of iron or lime. The others may occur at any depth between 2 and 6 feet and are apparently due to cementation by iron or lime. In some instances the compact layer contains very little clay for after being moistened the partially cemented sands are readily crushed between the fingers without becoming plastic. In a number of the subsoils there is high concentration of lime carbonate, which has reached degrees of hardness varying from soft chalky material to true hardpan.

The soils of this group are extensive, occupying a large proportion of the Victorville area. Excepting the isolated knobs and ridges of Rough stony land east of Victorville, they occupy the most of the east and west mesas and extend well into the foothills of the San Gabriel Mountains in the southwest part of the area. On the high alluvial fans the surface is broken by a number of deep washes and along the Mohave River Valley are separated from the recent alluvial soils by an abrupt escarpment. For about 1 mile back from the escarpment these materials are considerably eroded, but between this point and the hills to the south and extending many miles to the west they have a gently sloping surface with slight undulations due to lodgement of wind-blown sands around the desert shrubs. The greater part of this group of soils lies between 2,900 and 4,000 feet, although elevations within the group range from 2,800 to 5,000 feet above sea level. The old valley-filling soils have been grouped in four series of soils, the Mohave, Adelanto, Sunrise, and Hesperia series.

The surface soils of the types in the Mohave series are of pronounced reddish-brown to red color, the red tint usually being most evident when seen under moist field conditions. When dry the material in many places appears grayish, particularly where coarse quartz particles have been concentrated on the surface. The subsoil is reddish brown to red in color, the red tint usually being somewhat more strongly developed than in the surface soils. It is compact and includes partly indurated material, as well as irregular areas having a slightly to firmly cemented calcareous hardpan. The surface soils are in places slightly calcareous and the deeper subsoil usually includes zones in which lime has been concentrated. The series is derived from old valley-filling deposits, which have been subjected to long periods of weathering, disintegration, and erosion. The materials have their source in a variety of rocks, granite predominating. The topography of this series in this area is smooth, sloping, or undulating, although as mapped in previous surveys it has been in many places badly eroded. The surface material of the lighter textured types is readily drifted where unprotected by vegetation and areas are marked by low mounds and ridges. The soils of this series occur under arid conditions, are low in organic matter, and support a sparse covering of desert plants. Only small areas have been irrigated and they are of comparatively little agricultural importance. Two types of this series, the sand and loam members with subordinate phases, have been mapped in the Victorville area.

Resembling the Mohave soils, but distinguished from them by being less red, are the soils of the Adelanto series. The surface soils are brown, grayish brown, or reddish brown in color, a red or pinkish tint usually being present even in the areas where the soils are lightest colored. These soils, therefore, merge with those of the Mohave series. The subsoil ranges in color from grayish brown or brown to pronounced reddish brown or red. It tends to be of heavier texture than the surface soils, is compact and weakly cemented with lime. The surface soils typically are well leached and noncalcareous, but the deeper subsoil is calcareous and includes gray mottlings caused by lime accumulation. True cemented hardpan, however, is not typical of the series, although in the vicinity of Adelanto where the types merge into those of the Sunrise series, small patches having hardpan in the subsoil may sometimes be included. The soils are the product of mature weathering and decomposition of old valley-filling deposits, derived originally mainly from granitic rocks. Since deposition they have been modified by winds, much of the finer particles having been removed, leaving the surface composed of rather coarse material. The Adelanto soils are extensively developed on the floor of the desert, where, except for slight undulations due to wind-blown mounds, the topography is smooth or gently sloping. A few small bodies occur on the steeply sloping alluvial fans in the southern part of the area, and here the surface is considerably broken and eroded. Drainage is well established, but owing to the compact subsoil subdrainage is retarded. The loamy sand, sand, and sandy loam members, each with one or more phases, have been mapped in this survey.

Both the Adelanto soils and those of the Sunrise series were included with the Mohave series as mapped in the earlier reconnaissance survey covering a small part of this area.

Associated with the Adelanto soils and closely resembling them in surface characteristics, are the soils of the Sunrise series. Like the types of the former series, the surface soils are brown, grayish brown, or reddish brown in color, a red or pinkish tint being nearly everywhere discernible. The subsoil ranges in color from grayish brown or brown to pronounced reddish brown or red and is typically highly calcareous and underlain by a gray calcareous hardpan, ordinarily firmly cemented. Fragments of hardpan and particles of nodular or concretionary lime carbonate material are sometimes scattered over the surface. Thus the Sunrise soils correspond to the Adelanto soils in every respect save that both surface and subsoils are more highly calcareous and a cemented hardpan is present. They have been formed through long periods of weathering from old valley-filling deposits essentially similar to those giving the Adelanto soils. They occur on the desert plain at some distance from the foothill fans and have long since ceased to receive appreciable accretions through the agency of desert streams. They are typically developed in rather large bodies in the vicinity of Adelanto and throughout the northwest part of the area. As mapped in the Victorville area, the series includes eroded areas that are somewhat grayer and more calcareous than typical. In general, the soils have a smooth, or gently sloping topography with slight undulations due to wind-blown mounds.

Surface drainage is well developed, but underdrainage is retarded by the hardpan. The series is represented in this survey by the sand and the sandy loam types, the latter including eroded and rolling phases.

The Hesperia series includes types with grayish-brown or reddish-brown surface soils. The subsoil is of similar or a slightly more pronounced reddish-brown color and is generally slightly heavier or more compact than the surface soil. It is, however, friable and free from hardpan or other impervious layers, and the profile is usually quite uniform. The surface soil and subsoil in some places is feebly calcareous, the lime being quite uniformly distributed throughout the soil profile. The material is in places quite sandy, and here the surface is slightly wind blown, with a concentration of quartz particles giving it a grayish color. The series occupies old alluvial-fan slopes in desert valleys, the material of which is derived mainly from granitic rocks. The surfaces are generally smooth and uniform, with occasional slight wind-blown undulations and deeply entrenched stream channels. Drainage is good to excessive and the soils are free from alkali. Conspicuous angular particles of quartz and granite are usually present in the soil material. The series is distinguished from the Mohave series by its smoother topography, less oxidized and weathered character with consequent less pronounced reddish color, and more porous subsoils. The soils are low in organic matter, as one would expect in view of the arid conditions. Most of the areas support a typical desert vegetation. (Pl. XXI, fig. 2, and Pl. XXII, fig. 1.) The sand, loamy sand, and loamy fine sand types of this series are mapped in this survey.

The recent-alluvial soils are of comparatively small extent. The principal areas occupy a strip one-half to 1 mile wide along the Mohave River, and narrow strips border nearly all of the dry washes leading from the mountains to the desert. A number of areas also are developed on the recent-alluvial fans in the southern and western parts of the area. In the latter positions they merge into the associated old valley-filling soils with no distinct break in topography. They are the newest soils in the area, and, unlike the old valley-filling soils, they have not been essentially altered by weathering, leaching, or translocation of clay to the subsoil, but have the same general character of profile as when deposited. Near the stream and on the higher fans they are still receiving small accretions with each heavy rain. The materials are derived mainly from granitic rocks, and are usually highly micaceous. In the valleys the surface is generally smooth, though cut by dry, winding stream channels or marked by low ridges of wind-blown material. The fan areas are normally smooth and have a gentle, uniform slope. Differences in color, lime content, position, and other characteristics have given rise to three series, namely, the Hanford, Foster, and Cajon series. Riverwash, a miscellaneous nonagricultural type, may also be considered as of this group.

The surface soils of the types in the Hanford series are typically brown, light brown, or grayish brown in color. They are friable, porous, micaceous, and may extend to a depth of 6 feet or more without material change, or may be underlain by stratified materials of various textures that in many places are lighter in color than the surface soils. As occurring in this survey they are low in organic matter

and are readily drifted by winds. They are derived principally from granitic material and the coarser soils of the series contain a relatively large proportion of quartz. In the upper part of the Mohave Valley, where quartzitic material is especially abundant, the coarse types are somewhat grayer than typical, resembling the Tujunga series in that respect. The Hanford soils in this area are confined to recent stream-laid deposits in the flood plain of Mohave River. The lower areas are subject to overflow and small bodies are poorly drained and affected by alkali. The series in general, however, has good surface and underdrainage and does not contain injurious quantities of salts. The principal vegetation consists of sagebrush, native grasses, and some cottonwood trees along the river. Only two types, a coarse sand and very fine sand, are mapped in this area.

Similar to the Hanford soils in position, topography and origin are the soils of the Foster series. The surface soils are dark grayish brown in color and sometimes extend to a depth of 6 feet or more without pronounced changes in color or texture. Typically, however, the subsoil is slightly lighter colored than the soil and contains irregularly alternating strata of different textures. The soils are friable and micaceous and contain considerable organic matter. They are derived mainly from granitic rocks. They occur in rather low lying areas along the Mohave River, and surface drainage is poorly developed. In places the water table lies near the surface during the winter months and alkali has accumulated in small areas. In their native state the soils are covered with a good growth of grasses, sagebrush, and cottonwood trees. The Foster soils are among the more productive of the Victorville area. Two types, the fine sand and silt loam, are mapped.

The surface soils of the types included in the Cajon series are brown to light grayish brown in color, the brown tint usually being most pronounced under moist field conditions. The surface material is sometimes slightly wind blown and in areas in which there is a surface concentration of coarse quartz particles may appear distinctly gray. The subsoil is typically similar in color to the surface material and may be of similar texture though differing in some areas. The entire soil profile is prevailingly friable. The soil and subsoil are typically calcareous, effervescing feebly with dilute acid. The soils are formed of recent-alluvial deposits derived mainly from granitic rocks and containing much mica. The soils have been but little oxidized or eroded and occupy smooth alluvial fan slopes and associated stream bottoms. They occur under arid conditions and support a characteristic desert vegetation. They are well drained and leachy. The coarse sand, including a loamy and a dark-colored phase, and the loamy fine sand types represent the series in this survey.

Some of the soils in the Mohave River Valley mapped as Cajon in the earlier reconnaissance survey now appear to be more closely related to the Hanford and Foster types and are so recognized in the present survey.

In addition to the above-named soils, four classes of miscellaneous materials have been mapped. These are Rough stony land, Rough broken land, Riverwash, and Dunesand. The first three are nonagricultural. The Dunesand consists of light-colored, incoherent, wind-blown sand and is of little agricultural value.

The following table gives the names and actual and relative extent of the several soils of the area. Their distribution is shown on the accompanying map.

Areas of different soils.

| Soil. | Acres. | Per cent. | Soil. | Acres. | Per cent. |
|--------------------------------|--------|-----------|------------------------------|---------|-----------|
| Hesperia loamy sand | 37,632 | 16.6 | Sunrise sandy loam | 4,288 | 3.0 |
| Adelanto sandy loam | 27,904 | 15.9 | Eroded phase | 1,984 | |
| Rolling phase | 7,936 | | Rolling phase | 448 | |
| Heavy phase | 192 | 12.1 | Adelanto loamy sand | 3,840 | 2.3 |
| Hesperia sand | 27,392 | | Rolling phase | 1,280 | |
| Adelanto sand | 25,472 | | Cajon loamy fine sand | 4,032 | 1.8 |
| Rolling phase | 1,472 | 11.8 | Riverwash | 3,136 | 1.4 |
| Rough broken land | 20,480 | | Hanford coarse sand | 3,072 | 1.4 |
| Cajon coarse sand | 6,656 | | Mohave loam | 2,112 | 1.1 |
| Loamy phase | 6,208 | 6.7 | Playa phase | 448 | |
| Dark-colored phase | 2,560 | | Foster fine sand | 1,856 | .8 |
| Rough stony land | 10,048 | 4.4 | Hanford very fine sand | 1,024 | .5 |
| Hesperia loamy fine sand | 8,832 | 3.9 | Dunesand | 576 | .3 |
| Sunrise sand | 7,616 | 3.4 | Foster silt loam | 512 | .2 |
| Mohave sand | 4,480 | 3.4 | Total | 226,560 | ..... |
| Caliche phase | 3,072 | | | | |

MOHAVE SAND.

The surface soil of the Mohave sand consists of red or pronounced brownish red, loose, medium to coarse textured sand, with a depth of 12 to 15 inches. The subsoil is composed of red or brownish-red sand. In places this continues to depths greater than 6 feet, but ordinarily it is underlain by red compact heavier textured materials at 4 to 5 feet. In places the upper part of the subsoil is slightly more loamy than the surface soil, but the deeper part is usually loose and porous. This type of soil is low in organic matter, is friable and porous. In places it has been influenced by wind action. Both surface and sandy subsoil materials are free from lime accumulations or only mildly calcareous, but lime accumulations may occur in the deeper heavy-textured material.

The Mohave sand is of comparatively small extent. It is confined to a number of areas on the floor of the desert east of the Mohave River. In places it closely resembles the Adelanto sand, but is distinguished from it by a somewhat redder color. The surface is uneven or billowy owing to numerous low, wind-blown ridges and dunes. In places the greater part of the soil profile consists of material accumulated by the wind. Both the surface and subsurface drainage are adequate.

This type of soil is of little present importance, as less than 1 per cent of it is under cultivation. The native vegetation is sparse and typical of the desert, consisting of creosote bush, a gray desert shrub, (*Graya spinosa*), and a bright green bushy shrub (*Ephedra californica*). A small acreage of apples has been set on this soil type, but owing to shortage of water for irrigation many of the trees have died and others have made only a moderate growth. Unimproved land of this type of soil is held at \$10 to \$15 an acre.

The Mohave sand is not adapted to dry farming, and up to the present time very little water for irrigation has been developed from wells. The soil is deficient in humus and in case water is provided for irrigation and the land is brought under cultivation, it will be neces-

sary to add this in order to bind the soil, and to employ careful methods of cultivation to prevent drifting. On account of its light texture, this soil should be used in the production of alfalfa rather than grains.

Mohave sand, caliche phase.—The Mohave sand, caliche phase, differs from the typical soil in a number of important respects. The surface soil is brownish red or red, and is frequently of rather fine texture, approaching a loamy fine sand. It is fairly firm in structure and has been modified less than the typical soil by the wind. Red, compact heavier textured material is locally encountered at comparatively shallow depths, and gray, calcareous hardpan, varying in thickness, occurs at depths between 14 and 30 inches. Fragments of this underlying hardpan are common on the surface, giving the soil a somewhat lighter color than typical.

This phase is confined to the desert east of the Mohave River, where it occurs in a number of irregular areas closely associated with other Mohave soils and the types of the Sunrise series. The topography is smooth and but little modified by dunes. Surface drainage is adequate, but the subdrainage is retarded by the hardpan layer in the subsoil. Where this material occurs at shallow depths, the soil has a low capacity for storing water and would be poorly adapted to deep-rooted crops.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Mohave sand:

Mechanical analyses of Mohave sand.¹

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|---------|--|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| | | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> |
| 555754 | Soil 0 to 10 inches. . . . | 20.0 | 21.8 | 22.4 | 22.8 | 6.4 | 0.6 | 4.7 |
| 555755 | Subsoil 10 to 30 inches. . | 11.0 | 15.9 | 21.1 | 28.3 | 12.2 | 0.8 | 9.0 |
| 555756 | Lower subsoil 30 to 72 inches. | 10.4 | 16.0 | 25.0 | 29.2 | 10.6 | 2.6 | 7.5 |

¹ Analysis by Division of Soil Technology, University of California.

MOHAVE LOAM.

The surface soil of the Mohave loam consists of a pronounced reddish brown to dull-red compact loam with an average depth of 18 inches containing a relatively large percentage of sharp particles of the size of fine gravel and coarse sand. In undisturbed areas the surface is commonly strewn with such particles giving the appearance of a soil of coarse texture. The soil is low in organic matter and mildly calcareous. The subsoil consists of a reddish-brown to dull-red, irregularly stratified, compact gritty material of similar or of heavier texture. Typically the gritty subsoil is highly calcareous and is partly cemented, exceedingly compact, and impervious, resisting the penetration of water during extended periods of irrigation. Local areas are included in which a gray lime-cemented hardpan occurs at a depth of 5 to 6 feet. Once moistened, however, the typical subsoil is capable of storing a large quantity of water which can be retained for considerable periods by proper cultivation.

As mapped, this type of soil also includes small undifferentiated bodies somewhat browner in color than typical. In color these areas resemble the Adelanto soils, but appear more closely related to the Mohave series by their more compact subsoil and condition in relation to drainage.

The Mohave loam is of small extent. It is confined to a number of small areas in the eastern part of the survey. The largest area, covering less than 2 square miles, lies in sections 3 and 10 of T. 5 N., R. 3 W. Most of the other areas mapped are found in the northern and western parts of this township.

The topography is smooth and favorable for irrigation. Surface drainage is poorly developed, while the impervious character of the subsoil greatly retards the downward movement of water. As a rule, the type stands 1 or 2 feet lower than the surrounding sandy types, but with the scant rainfall of the region it receives but little run-off from adjoining soils.

The native vegetation on this soil includes very few shrubs, and is distinctive in that it consists almost entirely of a reddish-colored weed (*Eriogonium inflatum*) having a bulblike enlargement of the stem just above the ground. In the Victorville area, a general growth of this plant is indicative of this type of soil.

The Mohave loam is of little importance. A few apple orchards are being developed on it, but the aggregate acreage is small. None of these orchards have reached full bearing age. Most of the trees have been poorly cared for and show the effects of a shortage of water. They are given clean cultivation and irrigated with water pumped from wells. None of the land is dry-farmed.

Unimproved bodies of this type of soil are said to be on the market at \$10 to \$20 an acre, while orchard tracts provided with buildings and wells are held at considerably higher figures.

The Mohave loam is a rather difficult soil to handle and under the prevailing system of clean cultivation the surface has a tendency to bake and become compact. It has the physical characteristics in the field of a much heavier textured soil, and is composed of the various grades of sand and clay with only a small portion of silt. The soil is deficient in organic matter; and where water can be provided in sufficient quantities, cover crops could well be grown and turned under to supply this deficiency. The addition of barnyard manure would be very beneficial in supplying organic matter and loosening the soil, making it easier to work.

Mohave loam, playa phase.—The Mohave loam, playa phase, occupies a number of flat basins or shallow depressions resembling the dry beds of lakes. In an earlier survey⁶ the soil was mapped under the group name, Lahontan clay loams and clays, but the areas occurring within the limits of the present survey appear to be more closely associated with the material of the Mohave than of the Lahontan series. In fact the phase appears to consist essentially of Mohave materials occupying the flatter areas which have been modified by arrested drainage and by admixture or overdeposit of alluvial wash. If of greater extent it would probably have been recognized as a dis-

⁶ Idem.

tinct type of material properly correlated neither with the Mohave nor with the Lahontan series.

The surface soil differs from that of the typical Mohave loam by poorer drainage, a somewhat lighter color, heavier texture, and a lack of vegetation. The surface soil consists of 10 to 12 inches of grayish-brown or light yellowish brown or buff-colored compact silty clay loam or silty clay. The subsoil consists of red to reddish-brown irregularly stratified deposits, including materials of fine texture and those of coarse sandy and gritty character. Generally these are partly cemented with lime and very compact. Thin seams of gray calcareous material are sometimes encountered, but there is no evidence of extensive hardpan deposits.

This phase is confined to the eastern part of the area where it is closely associated with the typical Mohave loam. It also occurs as irregular basins within areas of Mohave sand. Its elevation is always slightly lower than the surrounding soils, and the surface is level or flat. After heavy rains the areas are flooded with a shallow sheet of water, which, the areas having no outlets and the subsoil being very impervious, remains until removed by evaporation. This rarely requires longer than a few days, and the phase usually presents a smooth, dry, pavementlike or mud-cracked surface entirely barren of vegetation.

None of this phase is cultivated. Owing to the absence of any facilities for drainage, it is considered practically valueless for agriculture.

ADELANTO SAND.

The surface soil of the Adelanto sand consists of light-brown or light reddish brown sand with an average depth of 14 inches. The soil is slightly loamy, but is loose and friable. It is free from lime accumulations or is but mildly calcareous. In most localities wind action has been an important factor in its formation. Through this agency much of the fine material originally in the surface layer has been removed and a thin covering of coarse granitic sand and fine gravel left behind. Where especially abundant, the surface has a light grayish brown color, though a trace of red is usually apparent, especially when the soil is moist. The upper subsoil consists of brown or reddish-brown gritty compact loam or clay loam or of partly cemented sandy loam, which when dry is stiff, tough, and intractable. At depths varying from 24 to 36 inches, the compact material grades into brown, reddish-brown, or slightly yellowish brown, gritty fine sandy loam, coarse sandy loam, or coarse sand of more friable, permeable structure. This material may extend below 6 feet, or may be interrupted by a second stratum of compact, heavier textured materials within the 6-foot section. Faint grayish mottlings or other evidence of slight accumulations of lime frequently occur in the more compact materials, and in the vicinity of Adelanto, where the type is associated with soils of the Sunrise series, small areas may be included which show concentrations of lime or "caliche" hardpan within less than 6 feet of the surface.

An area included with this type about 4 miles north of Victorville departs quite materially from the typical. This area occupies a steeply sloping alluvial fan extending down from an area of Rough

stony land. The soil consists of rather shallow, light-brown sand overlying compact reddish-textured material. Masses of granite, ranging from only a few feet to several feet across, protrude above the surface and in places underlie the soil at shallow depths. The area is shown by rock outcrop symbol. It has no agricultural value.

The Adelanto sand is a rather extensive soil type, confined principally to the Sunrise Valley. The largest and most important body occurs at Adelanto and is very irregular in shape, being about 4 miles in width at the northern boundary of the survey with constrictions farther south, due to intruding areas of Hesperia sand and types of the Sunrise series, while the southern part parallels the drainage ways in fingerlike projections for a distance of about 8 miles. Several other narrow bodies extending in a general north and south direction occur in the same vicinity. Still other areas are mapped south of Victorville and east of Hesperia, and small but important areas occur near the edge of the mesa east of the Mohave River.

In general, the topography is smooth or gently undulating. While the surface of virgin areas is marked by dunes, in most places they are not more than 1 or 2 feet high. They are, however, numerous enough to give the type a slightly billowy appearance, by which it can ordinarily be distinguished from the Adelanto sandy loam. Surface drainage is well developed, but the compact subsoil is slow to absorb moisture and is rarely penetrated by moisture even after the hardest rains.

Although the Adelanto sand is one of the important soils of the area, probably less than 15 per cent of it is under cultivation. The rest supports a characteristic desert growth of creosote bush, yucca, and small shrubs, and in places grasses and weeds afford a little grazing. Some areas have been cleared and improved, but owing to lack of a supply of water for irrigation they are untenanted and unused. Practically all of the cultivated acreage is in orchards, mainly apples. The principal development is at Adelanto, although good orchards are found in section 22 of T. 5 N., R. 6 W., and east of the river in sections 8 and 9 of T. 4 N., R. 3 W. Most of the orchards on this type of soil have been planted recently, the older ones ranging in age from 7 to 9 years. Owing to the small supply of water, the trees have been slow to come into bearing, or have not born heavily for their age.

This type of soil is used only under irrigation, the entire water supply being pumped from wells. The orchards are given clean cultivation. Owing to the inadequate supply of water during the growing season, some of them are irrigated during the winter months. The soil is low in organic matter and is easily drifted by winds. In order to reduce this, practically all the orchards are protected with wind-breaks of black locust, although most of the latter are still too young to have much effect.

Very little of this type of soil is being sold, but undeveloped tracts are said to be on the market at \$10 to \$25 an acre. Well-developed orchards are held at \$100 to \$350 an acre, depending on the age of the trees and the character of the improvements.

This type of soil is easily handled and with an adequate water supply should be adapted to the production of fruit. Only a few wells have been successfully developed, although a number have been put

down without obtaining water. The future usefulness of this type will depend upon the supply of water for irrigation, as it is not adapted to dry farming. Where adequate irrigation has been possible, the trees are thrifty and making a satisfactory growth. Aside from water, the greatest need of this soil is organic matter. This can be supplied either by the application of barnyard manure or by turning under green-manure crops, such as rye, wheat, or vetch.

Adelanto sand, rolling phase.—The Adelanto sand, rolling phase, is developed in one small area 4 miles west of Victorville and in a number of others of moderate extent between that town and Hesperia. The surface is too uneven to be irrigated and the soil is therefore nonagricultural.

The following table gives the results of mechanical analyses of samples of the soil, subsurface, and subsoil of the Adelanto sand:

Mechanical analyses of Adelanto sand.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|---------|----------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| | | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> |
| 575515 | Soil, 0 to 14 inches.... | 4.4 | 20.7 | 15.0 | 40.5 | 12.2 | 4.3 | 3.0 |
| 575516 | Subsurface, 14 to 30 inches..... | 3.4 | 14.4 | 9.9 | 29.1 | 13.4 | 11.0 | 18.7 |
| 575517 | Subsoil, 30 to 72 inches.. | 2.6 | 10.4 | 8.1 | 30.7 | 15.3 | 12.8 | 20.1 |

ADELANTO LOAMY SAND.

The surface soil of the Adelanto loamy sand consists of 8 to 15 inches of light-brown to light reddish brown loamy sand containing a quantity of small gravel, the latter consisting of light-colored sub-angular particles of granite ranging in size from one-fourth to one-half inch in diameter. The soil is low in organic matter, but is firm and compact. The subsoil typically is composed of two or more layers. The upper one, extending to an average depth of about 26 inches, is similar to the surface soil in color, but contains less gravel and is somewhat looser or less compact. In places this layer is absent and the surface soil passes abruptly into red, compact gritty sandy loam or loam containing a large proportion of coarse sand and fine gravel. This in turn is underlain at depths ranging from 3 to 4 feet by slightly reddish brown, compact sandy loam, high in fine gravel and coarse sand. Both surface and subsoil materials are free from lime accumulations or are only mildly calcareous.

This type of soil is of comparatively small extent, being confined to several small areas in the eastern part of the survey. The largest area, with an extent of about 5 square miles, occurs in the northeast part of T. 4 N., R. 3 W., where it forms a smooth, gently sloping plain along the southern edge of the desert. The other areas occupy rather steeply sloping fans extending a short way up the lower foot-slopes. The greater part of it has a favorable surface for irrigation. The drainage is well established.

Owing to its small extent, this type of soil is of little importance. Probably less than 2 per cent of it is cultivated, although a number of fields have been cleared and fenced and later abandoned. A small acreage of apple orchards has been developed with water pumped from wells, but the trees are not yet of full bearing age. Well cared

for orchards, which have had sufficient water, are thrifty in appearance and apparently have made a satisfactory growth. Most of the type is covered with a scattering growth of creosote bush and other desert shrubs, and is used for grazing.

No recent sales of this type of soil have been reported, but it is said to be held at about the same prices as the Adelanto sandy loam.

Owing to the favorable depth of the surface soil and the compact structure of the underlying material, this soil type is fairly retentive of moisture, although under the prevailing climatic conditions it is not adapted to dry farming. It is low in organic matter, and unstirred surfaces have a tendency to bake and become compact. With sufficient water and the addition of organic matter, it should be fairly well adapted to the common crops of the area.

Adelanto loamy sand, rolling phase.—The Adelanto loamy sand, rolling phase, differs from the typical soil mainly in topography. However, in a number of places the surface soil is lighter colored, more gravelly and porous, and somewhat deeper to the underlying heavier textured compact subsoil. Locally the phase consists of 3 feet or more of pale reddish brown gravelly coarse sand overlying compact red gravelly material of heavier texture. In places the surface soil is looser and more sandy and has been modified by winds. In the area 3 miles east of Victorville, gray calcareous hardpan is encountered at depths of 2 to 3 feet.

The largest area of this phase occupies an outlying ridge one-third mile in width and more than 3 miles in length, paralleling the south side of the desert in the southeast part of the area surveyed. A long narrow strip is also found about 3 miles east of Victorville. The topography is hilly, although somewhat smoother than typical Rough broken land. In addition to the common desert shrubs the vegetation includes cactus and plants resembling sotol weed and Spanish dagger. This phase provides a little better grazing than the typical soil, but being too hilly for irrigation, it is entirely unsuited to cultivated crops.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Adelanto loamy sand:

Mechanical analyses of Adelanto loamy sand.¹

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|---------|-----------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| | | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> |
| 575566 | Soil 0 to 12 inches | 9.4 | 11.9 | 15.9 | 31.9 | 13.5 | 4.8 | 13.5 |
| 575567 | Subsoil 12 to 26 inches. | 22.4 | 15.6 | 11.6 | 12.1 | 16.7 | 11.9 | 10.0 |
| 575568 | Subsoil 26 to 42 inches. | 20.6 | 17.0 | 16.1 | 13.3 | 5.7 | 6.9 | 20.1 |
| 575569 | Subsoil 42 to 72 inches. | 25.9 | 21.4 | 17.7 | 13.5 | 5.7 | 4.0 | 11.2 |

¹ Analysis by Division of Soil Technology, University of California.

ADELANTO SANDY LOAM.

The surface soil of the Adelanto sandy loam consists typically of 12 to 14 inches of a brown or light-brown to reddish-brown light-textured sandy loam, containing relatively large proportions of coarse sand and fine gravel. The coarse material consists of sharp particles of granite and quartz and is frequently concentrated on the surface, giving the surface soil a grayish-brown appearance in which a pale-red or pinkish tint is commonly conspicuous. The subsoil consists

of reddish-brown or brownish-red, exceedingly compact gritty material of similar or of somewhat heavier texture. In places the material is partly cemented and contains a quantity of sharp coarse sand. At depths ranging from 3 to 5 feet, the compact material passes into irregularly stratified coarse-textured materials which are usually more open and porous. The surface material is usually well leached of lime, but slight accumulations may occur in the compact subsoil layer. In places, notably a few miles south of Victorville where the type is somewhat eroded, the surface soil is shallow. Here the type consists of about 4 inches of grayish-brown light-textured sandy loam overlying a red, compact gritty heavier textured material which passes, at an average depth of 18 inches, into brown or slightly reddish brown, compact sandy loam. At depths varying from 3 to 5 feet the material becomes loose, gravelly and porous. Along the east side of the area the type is also shallow, but is smooth and uneroded. Here the soil is somewhat heavier in texture, but the surface is covered with a thin layer of light-gray and pinkish colored particles of granite, varying from one-fourth to one-half inch in diameter. An area of fine sandy loam texture occupies a strip one-half to three-fourths mile wide extending southwest through sections 2, 10, 11, and 15 of T. 4 N., R. 6 W. In this area the reddish-brown, friable surface soil is underlain at a depth of 14 inches by slightly more compact material of the same color and texture. At a depth of 30 inches there occurs a reddish-brown, compact loam or clay loam which, in common with the rest of the type, is underlain at 5 feet by light-textured sandy loams of friable, permeable structure.

Four areas of gravelly character are indicated on the map by means of gravel symbols. One, occurring near the base of the San Bernardino Mountains in the southeast part of the area, is representative of the rest of the type except that the surface is covered with gravel and cobbles varying in size from 1 to 6 inches in diameter. The soil in the other three areas, occurring on the broken ridges and foothills 1 to 3 miles northeast of Victorville, is somewhat grayer, more calcareous, and in places overlies bedrock at shallow depths. None of these gravelly areas is of agricultural value.

The Adelanto sandy loam occurs in a number of widely separated areas. A large area lies in the southeastern quarter of T. 5 N., R. 3 W., in the eastern part of the survey and others occur east and north of Hesperia. Other areas lie on the terrace slopes east of the Mohave River and at various points in Apple Valley. Many small bodies occur southwest of Victorville, along the lower or northern side of Baldy Mesa, and on the high fans and foothills bordering the San Gabriel Mountains in the southwest corner of the survey. Most of these latter areas occur as long narrow ridges of low elevation, extending in a northeasterly-southwesterly direction along minor drainage courses.

In the larger areas in the eastern part of the survey the topography is nearly level. In general, the smaller areas are slightly rolling or gently undulating, while near the base of the mountains the surface is that of rather steeply sloping fans. Few drainage courses cross the type and these are intermittent and rarely carry water. Under the prevailing arid conditions, the surface drainage is always adequate, but

with irrigation the underdrainage would be slow because of the compact character of the subsoil.

This type of soil is of little present economic importance, as only a small proportion of it is being cultivated. The greater part of the type is still covered with a desert vegetation of creosote bush, hop sage, giant yucca, and a scattering growth of bunch grass. In the eastern part of the area sagebrush is common, and on the fans where moisture is more abundant there is considerable juniper. The uncleared areas are utilized to some extent for grazing cattle.

The cultivated areas are devoted principally to apples, although most of the trees have not yet reached a profitable bearing age. Some of the orchards are barely alive, and many of the trees have died through lack of water and neglect. Alfalfa occupies a few small patches and where sufficient water is applied returns a yield of 4 to 5 tons per acre per season. In growing apples the trees are given clean cultivation, the water supply in most cases being considered insufficient to support cover crops in addition to the trees.

Land of this type of soil is valued at about the same price as the Adelanto sand.

Except in the most favorable localities, as on the sloping fans in the southwest part of the area, where rainfall is somewhat greater, the Adelanto sandy loam is not adapted to dry farming. In the above-mentioned locality moderate yields of grain hay can be expected in seasons of favorable rainfall. Under irrigation the deeper phases of the type should be adapted to the common crops of the area. The shallow areas are somewhat droughty. All the type is deficient in organic matter and would be improved by the growing and plowing under of green cover crops.

Adelanto sandy loam, rolling phase.—A number of bodies are outlined on the map as Adelanto sandy loam, rolling phase. The soil in these corresponds to the rest of the type, except that the surface is more rolling and broken and that the surface soil is usually more shallow. A number of such areas are mapped in the eroded section along the west side of the river south of Victorville. A few areas lie on the terrace slopes east of the river and quite a number are found on the high fans in the southwest and southeast parts of the area. In the latter position the phase merges into Rough broken land with increasing elevation. Here the rainfall is sufficient to produce a growth of juniper, oaks, and chamisal, with a fair covering of weeds and grasses. These areas provide considerable grazing for cattle. Throughout the greater part of this soil phase the surface is noticeably smoother than that of Rough broken land, and in a region of greater rainfall the topography would not necessarily preclude cultivation. However, since irrigation is essential for success and the surface is too uneven to be conveniently watered, the phase is considered nonagricultural.

Adelanto sandy loam, heavy phase. The Adelanto sandy loam, heavy phase, is represented by a few small areas of soil of somewhat finer and heavier texture than the typical Adelanto sandy loam. These merge with the areas of the typical soil and the boundaries between the two are frequently indefinite, but if greater in extent the phase would have been recognized as a distinct type of the Adelanto series.

The surface soil to a depth of 12 to 15 inches consists of a brown to rather dull brown fine sandy loam to clay loam, with a surface

covering of about 1 inch of light-brown fine sandy loam containing a relatively large proportion of angular fragments of light-colored granitic gravel. The subsoil consists of brown, or brownish-red, gritty, sandy loam or loam of moderately compact structure and extending to a depth of 24 to 30 inches, where it is underlain by irregularly stratified deposits of brown gritty sandy loam, loam, and sand. This substratum is highly calcareous, exceedingly compact, and in many places contains many rounded gravels and cobbles, loosely cemented into a mass. While this compact layer is rarely more than 2 feet in thickness, a number of strata of the same character of materials underlie the phase to a depth of many feet.

The Adelanto sandy loam, heavy phase, is confined to the higher alluvial fans in the southwest part of the survey. It is most typically developed on the crests of narrow ridges that extend up from the valley and finally merge into areas of Rough broken land. Along these contacts rounded boulders 8 inches to 2 feet in diameter may be present on the surface. Only one area has been shown on the map.

The topography is rolling or broken, with many long, narrow ridges separated by steep-sided draws. As a rule only the crests of the ridges are sufficiently smooth for cultivation. The areas lie on the upper margins of the old alluvial fans, 1,500 feet above the Mohave Valley, or at elevations of 4,200 to 4,500 feet above sea level. Surface drainage is well developed, and in some areas the run-off is excessive and the land is being damaged by erosion.

At present this soil has no agricultural importance, as none of it is under cultivation. A small part of it has been taken up as grazing land, for which purpose it is fairly well adapted. The native vegetation consists mainly of juniper, with a scattering growth of bunch grass and various desert shrubs. Associated with other types, it is held at \$10 to \$15 an acre.

Where the topography is favorable and the surface free from stones it should be fairly well adapted to dry farming. It is retentive of moisture and it is situated on the higher slopes, where it receives somewhat more rainfall than the soils of lower parts of the desert. Only moderate yields, however, could be expected. It is probably best adapted to the production of grain hay for use in feeding stock on the adjoining rougher areas.

SUNRISE SAND.

Closely associated with the Adelanto sand is the Sunrise sand. These soils resemble each other in color, origin, and topography, but differ in the nature of the substratum, which in the latter type consists of a gray, lime-cemented hardpan in the subsoil.

The surface soil is a light-brown to a reddish-brown, medium to fine textured sand, with an average depth of about 14 inches. The soil is calcareous and loamy, but is loose in structure, owing to the appreciable content of sharp, coarse sand, and fine granitic gravel. Where the coarse material is concentrated on the surface the color becomes a grayish brown although, like the Adelanto sand, a pinkish tint is evident and especially marked when the soil is moist. The soil is lacking in organic matter, and locally the surface has been modified considerably by wind.

The subsoil is a highly calcareous brown or reddish-brown partially cemented sandy loam or compact gritty material of heavier texture, resting on gray, calcareous hardpan at some depth between 24 inches and 5 feet. Locally this "caliche" or lime deposit, which is quite firmly cemented when dry, becomes soft and chalklike under irrigation, and is fairly permeable to moisture and penetrable by tree roots. In desert areas, however, and in some of the irrigated fields it is very hard.

This type of soil is only moderately extensive. It is confined principally to the Sunrise Valley. The largest areas occur at or near Adelanto and in the northwest corner of the area surveyed. Several narrow strips are mapped along the upper margins of the rolling section west and southwest of Victorville, and a few small areas occupy similar positions east of the river.

The topography is smooth, except for slight undulations due to wind-blown mounds. The type is gently sloping, providing good surface drainage and favorable fall for irrigation. The subdrainage, however, is retarded by the compact subsoil and the dense layers of hardpan.

The only important development on this soil type is near the town of Adelanto. About 10 per cent of it is under irrigation, and the rest supports a characteristic growth of desert shrubs, grass, and weeds and is used in a small way for grazing. The principal crops are apples and pears, the former occupying somewhat the larger acreage. There are also a few peaches, apricots, grapes, and a small acreage of alfalfa. Among the varieties of apples grown are the Rome Beauty, Jonathan, Delicious, and Winesap. None of these trees have reached their most productive age, most of them being around 6 years old. The average yield of alfalfa is about 4 tons per acre, with a range from 3 to 5 tons.

Most of the orchards are given clean cultivation, although in some instances rye is grown during the winter months and plowed under early in the spring. Owing to the scarcity of water during the summer, many of the orchardists continue to irrigate throughout the winter, although cultivations are not very general at this time of the year. The farms on this type of soil are small and all of them are under irrigation. The water is obtained by pumping from wells, the depths ranging from 88 to 124 feet.⁷

Undeveloped land of this type of soil in the vicinity of Adelanto is on the market at \$40 to \$50 an acre and at \$15 to \$30 an acre at some distance from this town. Well-developed orchards under irrigation bring \$350 an acre.

The Sunrise sand is very deficient in organic matter, and an effort should be made to supply this constituent either by applying barnyard manure or by plowing under green-manure crops, such as barley, rye, or vetch. Where water can be had in sufficient quantities, alfalfa would undoubtedly prove beneficial in orchards, as it would prevent drifting, and by increasing the humus supply would render the soil more retentive of moisture. Owing to the hardpan and other compact strata in the subsoil, the underlying materials absorb water very slowly and as a result considerable care is necessary in irriga-

⁷Report of the Utilization of the Mohave River for Irrigation in Victor Valley, California. Bul. No. 5. Department of Engineering, State of California.

tion. On account of the depth at which water is obtained in wells, the development of orchard tracts by pumping on any of the Mesa lands is costly and should not be attempted without considerable funds. Judging from the appearance of young orchards at Adelanto, it would seem that where water is available this type of soil is well suited to this industry. The soil type however, is entirely unsuited to dry farming.

SUNRISE SANDY LOAM.

The surface soil of the Sunrise sandy loam consists of about 12 inches of brown to reddish-brown light-textured sandy loam containing a large percentage of coarse sand. The subsoil, to an average depth of about 30 inches, consists of irregularly stratified deposits of reddish-brown to red compact loam or clay loam, or reddish-brown exceedingly compact sandy loam of relatively high clay content. Frequently this sandy loam strata is partly cemented and contains gray streaks of lime carbonate. Appearing at various depths between 24 inches and 5 feet, there appears a gray, calcareous hardpan. In places this is only a few inches in thickness; in others it occupies the entire profile between 4 and 6 feet in depth. The calcareous material exists in various stages of development ranging from soft, marly material that is easily moistened, to true indurated hardpan. It is probable that with the application of water some of the hard layers will soften and become penetrable to plant roots, but the harder parts will most likely remain highly impervious both to water and roots.

The Sunrise sandy loam is of small extent. Two strips, varying from less than one-fourth to 1 mile in width and about 3 miles in length, occur just east of Adelanto. One small area lies near the northwest corner of the survey. Several narrow strips occur west and south of Victorville, and a few are developed east of the Mohave River and near the east side of the area.

The topography is smooth with only slight undulations due to wind-blown material. No drainage ways cross the type, the areas occupying slight elevations or ridgelike positions between the dry water courses. The type has sufficient slope to provide surface drainage, but the underdrainage is poor on account of the hardpan layers.

This soil type has little importance, as not more than 1 per cent of it is cultivated. The rest is covered with a scant growth of creosote bush and other low shrubs, and has a slight value for grazing. About the only development attempted is in the vicinity of Adelanto. Here a small acreage of apples and pears has been planted, but the trees have not yet reached bearing age. They are given clean cultivation and irrigated from wells. The cost of pumping is high, but where the trees have received sufficient water, they appear to be fairly thrifty.

No recent sales of this type of soil have been reported but it is said to be held at about the same price as the Sunrise sand.

The Sunrise sandy loam is entirely unsuited to dry farming, and the development of wells for irrigation is costly and uncertain. In areas where the hardpan occurs near the surface the soil has a low capacity for storing moisture, but where the soil is deep it is about



S. 11490

FIG. 1.—“DRY-FARM” DESERT HOMESTEAD ON HESPERIA SAND

Note characteristic smooth topography, scattering growth of yucca (Joshua tree), and type of dwelling, now abandoned



S. 11504

FIG. 2.—LOWER ALLUVIAL FAN SLOPES IN THE SOUTHWESTERN PART OF THE AREA

The soil is the Hesperia loamy sand. Note topography and typical vegetation of creosote bush and yucca (Joshua tree)



S. 76993

FIG. 1.—VIEW IN APPLE VALLEY SHOWING CHARACTERISTIC HEAVY GROWTH OF CREOSOTE BUSH ON SOILS OF THE HESPERIA SERIES



S. 10992

FIG. 2.—EXPOSED SECTION IN SOIL OF THE CAJON SERIES NEAR PHELAN SHOWING IRREGULAR STRATIFICATION AND POCKETS OF GRAVEL AND STONE

as well adapted to the common crops of the area as is the Adelanto sandy loam

Sunrise sandy loam, rolling phase.—The Sunrise sandy loam, rolling phase differs from the typical soil only in having a more rolling topography. The surface is too uneven to be conveniently irrigated, and as the type is not adapted to dry farming, it is practically non-agricultural. It is represented by only one small area occurring about $1\frac{1}{2}$ miles southwest of Victorville.

Sunrise sandy loam, eroded phase.—The eroded phase of the Sunrise sandy loam comprises materials that are predominantly gray and therefore not representative of the Sunrise series. It appears, however, that the areas have resulted from removal of the typical browner surface material and the exposure of the underlying highly calcareous gray material, and the areas have been mapped accordingly. The surface is generally undulating or smooth and not eroded in the sense of being characterized by rough topography.

The surface soil consists of light-gray or brownish-gray, friable, calcareous sandy loam with an average depth of about 10 inches. The immediate surface usually contains a large percentage of coarse sand and fine gravel and is frequently strewn with lime concretions and angular fragments of gray calcareous hardpan. The subsoil is quite variable in color, texture and depth. It commonly consists of irregularly stratified deposits of light-gray or brownish-gray sandy loam, loam, or clay loam. Typically one of these strata is exceedingly compact, while all are highly calcareous. The compact layer is not confined to any particular texture nor to any uniform depth but ordinarily occurs within less than 3 feet of the surface. At varying depths the soil is in many places underlain by a gray, calcareous hardpan, ranging in thickness from a thin seam to a layer 4 or more feet through. The thinner seams may occur within a few inches of the surface; the thicker layers commonly occur 4 feet or more below. In places the upper part of these deposits is rather soft and chalk-like, but in the majority of the occurrences they are hard throughout and practically impervious.

As mapped in this area this phase includes small areas of sand, very fine sandy loam and loam. In the areas of loam texture the surface is decidedly gray in color and is frequently silty in texture and very micaceous. The subsoil is smooth, micaceous very fine sand extending to depths of 3 to 5 feet where it is underlain by hardpan.

The Sunrise sandy loam, eroded phase, is of small extent. A number of narrow areas including those of loam texture, occur 2 to 5 miles west, and others 3 miles north and 2 to 3 miles east of Victorville. A small area of fine sandy loam texture included with this phase is situated in the extreme northwest corner of the area.

Owing to the greater resistance to weathering afforded by the hard gravel covering, areas of this phase of soil stand at a slightly higher level than those of surrounding soils. The topography is usually that of low narrow ridges whose slopes generally terminate in definite drainage courses. In places the slopes are somewhat furrowed by erosion and in general the surface is unfavorable for irrigation.

This phase is of very little importance. A few small areas have been cleared, but at present none of them are being farmed. Where the

hardpan lies at considerable depths, there is a scattering stand of bunch grass and a fairly good growth of creosote bush and other desert shrubs, but shallow areas produce only a scanty vegetation. Owing to the presence of hardpan or other compact layers, the phase is droughty, as it is unable to store an adequate supply of moisture. It is unsuited to dry farming, and only a small proportion of it is sufficiently smooth for irrigation.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical Sunrise sandy loam:

Mechanical analyses of Sunrise sandy loam.¹

| Num- ber. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|--------------|----------------------------|------------------|------------------|------------------|------------------|--------------------|------------------|------------------|
| | | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> |
| 575518 | Soil, 0 to 16 inches.... | 11.0 | 8.2 | 9.7 | 23.3 | 26.9 | 9.6 | 11.8 |
| 575519 | Subsoil, 16 to 36 inches.. | 18.0 | 14.0 | 12.5 | 12.6 | 6.7 | 4.2 | 30.1 |

¹Analysis by Division of Soil Technology, University of California.

HESPERIA SAND.

The surface soil of the Hesperia sand consists of about 12 inches of light-brown to brown slightly loamy sand. The top layer, about an inch thick, is generally coarser than the material below and carries fine angular particles of gravel. Below this shallow covering the soil is slightly coherent, though not compact. The subsoil typically is a light-brown to brown, medium textured loamy sand or sandy loam of slightly compact structure underlain at 24 to 36 inches by brown, friable sandy loam or loamy sand. Both soil and subsoil are permeable. Locally, as in the vicinity of Hesperia, brown or reddish-brown clay loam underlies the type at 4 to 6 feet in depth. It is probable that the compact subsoil of the Adelanto soils underlie this type in part at least at various depths and that the Hesperia sand represents a deeper development of the Adelanto sand. The Hesperia sand is confined mainly to the open desert and is not developed on the higher alluvial fans. It has been formed under a condition of less rainfall than has the Hesperia sandy loam. This has resulted in a lower content of organic matter and a somewhat lighter color.

The Hesperia sand is a comparatively extensive soil. Large areas occur south and west of Adelanto and in the southwestern part of Sunrise Valley. Several narrow strips occupy drainage courses 3 to 5 miles west of Victorville. An important body is mapped at Hesperia, and others occur between this town and the river, and on the first bench east of the river. One rather extensive area lies about 2 miles south of the northeast corner of the survey.

In general the topography is smooth, with no great difference in elevation within the limits of any particular area. In detail the surface is made uneven by many wind-blown mounds averaging 2 or 3 feet in height. Except for these, the larger areas appear nearly level, but there is always sufficient slope to give good drainage. The type occurs on the gently sloping mesas, as low smooth ridges between

the drainage courses, and forms strips in the narrow valleys of some of the older washes. A few small areas occupy gently sloping alluvial fans. In the vicinity of Hesperia there is an area with a smooth, firm surface like that of the Hesperia loamy sand. This area appears to represent a condition intermediate between the Hesperia sand and the Hesperia loamy sand. The topography of the greater part of the type is favorable for irrigation, but owing to the slight unevenness of the wind-blown surface, the cost of leveling is slightly greater than on the loamy sand member of the series.

The native vegetation is rather sparse, consisting mainly of creosote bush, interspersed with other desert shrubs and some bunch grass.

Although not more than 5 per cent of the Hesperia sand is cultivated at the present time, it is nevertheless one of the important upland soils of the area. The principal development is at the town of Hesperia. Small fields also are being irrigated 5 miles south of Adelanto, and on the first bench east of the river near the Apple Valley School. The principal crops are apples, grapes, and alfalfa, the first named occupying the largest acreage. Peaches, plums, and apricots are grown in a way but are of little commercial importance. Although some of the fruit trees at Hesperia are said to be 30 years of age, they have been watered irregularly and otherwise poorly cared for and no accurate record of yields is available. At the present time, however, the returns are light. These old apple orchards consist of more than a dozen varieties, including Baldwin, Black Ben, Ben Davis, and Stayman Winesap, with comparatively small acreages of each, making spraying difficult and marketing unsatisfactory. The orchards on this soil type in other sections of the area are still too young to have reached a profitable age. The principal varieties of grapes are Alexandria (*Muscat of Alexandria*) and Sultanina (*Thompson Seedless*), with some Flame Tokay. The quality is said to be excellent. Alfalfa returns 3 to 5 tons with an average of about 4 tons per acre.

This type of soil has about the same range in value as the Hesperia loamy sand. It is handled in the same manner, and is adapted to the same range of crops. The soil is of low water-holding capacity and requires frequent and copious irrigation. It is also deficient in organic matter, which can best be supplied by turning under green-manure crops.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Hesperia sand:

*Mechanical analyses of Hesperia sand.*¹

| Number | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|--------|--------------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| | | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> |
| 575534 | Soil, 0 to 18 inches | 6.6 | 14.6 | 18.8 | 30.3 | 22.7 | 2.6 | 2.9 |
| 575535 | Subsoil, 18 to 50 inches .. | 9.9 | 13.3 | 16.0 | 30.8 | 19.8 | 3.8 | 4.7 |
| 575536 | Lower subsoil, 50 to 72 inches | 3.4 | 5.2 | 9.8 | 28.7 | 30.3 | 10.2 | 10.8 |

¹ Analysis by Division of Soil Technology, University of California.

HESPERIA LOAMY SAND.

The surface soil of the Hesperia loamy sand consists of light-brown to brown, friable, light-textured loamy sand, about 12 inches deep, with a large content of coarse sand and fine gravel concentrated on the surface, through removal of the finer soil particles by the wind. The coarse material gives the surface a grayish-brown appearance, although the red or pinkish tints that characterize the desert soils are generally discernible. The subsoil typically is similar to the surface soil in color and texture, but is a little more compact. It is feebly calcareous, but contains no cemented or compact layers to interfere with the penetration of water or plant roots. It is much more friable and permeable than the subsoils of the Adelanto or Sunrise soils. Locally, the material below 4 feet in depth consists of moderately compact gritty clay loam or loam.

In mechanical composition the material of this soil type differs but slightly from that of the Hesperia sand. It contains, however, a slightly higher content of silt and clay, and in the field is consistently more coherent and loamy, having the characteristics of a sandy loam.

The color of this type of soil is subject to some variation, depending on the locality in which it occurs. In the Baldy Mesa section and the high alluvial fans in the southwest part of the area, more rainfall has given the soil a somewhat browner color, the brown or slightly reddish brown tint being more pronounced when the soil is moist. Here the friable soil is moistened during the winter months to an average depth of 30 inches, whereas on the open desert at lower elevations moisture rarely penetrates more than 10 or 12 inches below the surface.

As mapped in this survey the type includes a number of areas in which the surface soil is lighter textured than typical. The most noticeable example is about 2 miles west of Hesperia. Here, and elsewhere in small tracts, the soil contains a large proportion of coarse material. The type as a whole is low in organic matter, and the soil in these areas is especially so. The surface, however, is smooth like the typical soil and low wind-blown mounds do not occur as in areas of the Hesperia sand.

As on nearly all the desert soils of the area, many homesteads were taken up on the Hesperia loamy sand, partly improved, and later abandoned because of the unprofitableness of dry farming and the difficulty of obtaining water for irrigation. Out of the 115 dwellings observed on this soil type, only 24 were found to be occupied at the time of the survey. Probably not more than 3 or 4 per cent of the type is actually under cultivation. The uncleared areas support a growth of creosote bush, giant yucca, hop sage, a scattering of grasses and weeds, and some juniper and sagebrush on the higher elevations. The principal crops in the order of their importance are apples, pears, cherries, and grain hay. In addition there are small acreages of alfalfa, corn, apricots, plums, and grapes. The fruit crops and alfalfa are confined mainly to the first bench east of the river and are irrigated with water pumped from wells. The corn and grain hay are produced in the Baldy Mesa section by dry farming. Of the fruit crops, apples occupy the largest acreage. The principal varieties are Rome Beauty, Jonathan, and Stayman Winesap. Winter Bartlett is the principal pear grown.

The apple trees range from 7 to 9 years of age and are just coming into profitable bearing. Five-year-old cherry trees are said to have averaged about 50 pounds to the tree. Pears, apricots, and grapes do well, but no accurate records of yields are available. Dry-farmed barley and wheat average about 1 ton of hay per acre, and corn about 20 bushels per acre. Irrigated alfalfa is cut four or five times per season, with an average yield of about 1 ton per cutting.

All of the orchards on this soil type have been given clean cultivation. They are irrigated, on the average, 6 times during the season and cultivated with a spring-tooth harrow, and sometimes with a pulverizer, after each irrigation. A small quantity of barnyard manure is applied to the more backward trees, but aside from this no organic matter has been added to the orchards.

The well-cared-for orchards on this type of soil are held at \$400 to \$550 an acre. Partly developed dry-farmed tracts can be bought for \$15 to \$25 an acre, depending on location and improvements.

Where water for irrigation is available, the Hesperia loamy sand is well adapted to the production of apples, pears, cherries, apricots, and grapes. It is also well suited to alfalfa. The soil is low in organic matter, and responds quickly to the application of barnyard manure or the plowing under of cover crops. An attempt has been made to grow alfalfa on this type of soil, without irrigation, in cultivated rows. While the stand obtained is too thin and spotted for a satisfactory hay crop, it is sufficient to furnish a considerable amount of grazing. However, under the prevailing climatic conditions, the land can not be said to be suited to dry farming.

The following table gives the results of mechanical analyses of samples of the surface layer, soil, subsoil, and lower subsoil of the Hesperia loamy sand:

Mechanical analyses of Hesperia loamy sand.¹

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|---------|-------------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| | | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> |
| 575545 | Surface, 0 to $\frac{1}{4}$ inch... | 16.3 | 16.7 | 16.8 | 19.2 | 15.8 | 7.0 | 6.7 |
| 575546 | Soil, $\frac{1}{4}$ to 12 inches... | 16.7 | 15.7 | 17.4 | 17.7 | 20.6 | 8.2 | 5.9 |
| 575547 | Subsoil, 12 to 48 inches | 13.3 | 14.1 | 14.7 | 26.1 | 16.5 | 6.7 | 8.5 |
| 575548 | Lower subsoil, 48 to 72 inches..... | 11.3 | 11.2 | 14.2 | 21.4 | 21.2 | 7.9 | 13.0 |

¹Analysis by Division of Soil Technology, University of California.

HESPERIA LOAMY FINE SAND.

The surface soil of the Hesperia loamy fine sand consists of a brown friable loamy fine sand, with an average depth of about 12 inches. The immediate surface is usually covered with small quartz fragments of the size of fine gravel and coarse sand. Locally this material is sufficiently abundant to give the surface a grayish appearance, but a higher content of organic matter, due to a somewhat greater rainfall, is usually sufficient to make the surface slightly darker colored than that of the Hesperia sand. The subsoil is a brown fine sandy loam of mellow, friable structure grading at a depth of about 36 inches into brown, slightly compact sand or sandy loam containing small quantities of fine gravel.

The Hesperia loamy fine sand is fairly extensive. With the exception of a small area about 2 miles southeast of Victorville it is confined entirely to the western part of Baldy Mesa, or principally to T. 4 N., R. 6 W., in the southwest corner of the area surveyed. It occurs as rather broad, plainlike areas broken by shallow, desert washes. The surface is smooth and in places appears almost level, but there is a gentle, uniform slope of about 100 feet to the mile which, with the permeable soil and subsoil, gives excellent drainage. The type is developed at high elevations, ranging from 3,500 feet at its lowest occurrence to about 4,250 feet above sea level near the foothills.

Although a large proportion of this type was at one time taken up by homesteaders who made improvements and cleared small acreages, fully one-half of the holdings are now uncultivated and abandoned. At the present time not more than 5 per cent of it is in cultivation. The rest supports a vigorous growth of juniper, yucca, grasses, and weeds, with some scrub oak and chamisal at the higher elevations. About the only crops grown are wheat and barley hay and early ripening varieties of corn. The first two occupy the greater part of the cultivated acreage. The yields vary considerably with the character of the seasons. The yield of grain hay averages about 1 ton per acre and of corn about 20 bushels per acre. These yields are obtained by dry farming, as none of the type is under irrigation. In the production of hay, the land is prepared and seeded either in the fall, or after the soil has become moistened by the first winter rains. The hay is cut about the middle of May.

This type of soil is held at \$15 to \$25 an acre, depending on improvements and location with respect to roads.

Although the Hesperia loamy fine sand is somewhat better adapted to dry farming than any of the other upland soils of the area, the greater part of it is poorly suited to this purpose owing to adverse climatic conditions and profitable yields can be assured only with irrigation. Fairly good results are obtained on the higher elevations where rainfall is somewhat greater than the average. In these situations the type is fairly well suited to the production of grain hay and other forage crops for use in connection with the grazing of livestock on the range.

The following table gives the results of mechanical analyses of samples of the soil, subsurface, and subsoil of the Hesperia loamy fine sand:

Mechanical analyses of Hesperia loamy fine sand.

| Num- ber. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|--------------|--------------------------------------|------------------|------------------|------------------|------------------|--------------------|------------------|------------------|
| | | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> |
| 575526 | Soil, 0 to 12 inches..... | 4.6 | 12.6 | 7.2 | 23.4 | 29.1 | 11.1 | 6.9 |
| 575527 | Subsurface, 12 to 30 inches | 4.2 | 12.0 | 6.3 | 24.8 | 30.2 | 14.3 | 8.2 |
| 575528 | Subsoil, 30 to 72 inches.. | 8.0 | 17.6 | 7.4 | 26.0 | 23.9 | 11.7 | 5.3 |

HANFORD COARSE SAND.

The surface soil of the Hanford coarse sand is a light-brown or light grayish-brown, loose, micaceous coarse sand containing a small quantity of fine waterworn gravel, and but very small proportions of finer grades of sand or of silt and clay. In the larger areas at some distance from streams, the soil is uniform in color and texture to a depth of 6 feet or more, but in the upper part of the Mohave River Valley and in the vicinity of old filled-in channels it is subject to considerable variation in profile. In places the subsoil consists of loose deposits of light-colored gravel containing numerous bowlders 6 inches to 2 feet or more in diameter. Local gravelly depressions containing a quantity of cobblestones cross the type at intervals, but stones are rarely numerous enough to interfere with tillage.

Included with this type are a few areas of brownish-gray soil resembling types of the Tujunga series, of similar origin and occurrence, which are distinguished from the Hanford soils by their gray color. Another variation occurs at the mouths of gullies and canyons, where recent floods have carried down and spread out coarse Hanford materials over the darker colored materials of the Foster series. Here strata of dark-colored sand, fine sandy loam, and silt may appear at shallow depths.

The Hanford coarse sand is low in organic matter, porous and leachy. It is noncalcareous and free from injurious quantities of alkali. In places it resembles Riverwash, but differs from it in having a somewhat firmer surface, more vegetation, and greater freedom from overflows.

The Hanford coarse sand is of small extent. It is confined to the first bottoms along the Mohave River, where it occurs as irregular strips one-fourth to one-half mile in width roughly paralleling the stream. The largest and most typical areas are mapped in the upper part of the valley within a few miles of the point where the river leaves the mountains.

The surface is smooth, with a gentle fall down the stream. In places it is traversed by channels of Riverwash and by small areas of Dunesand. Normally stream channels are sufficient to carry all the overflow when the river is high, but the type stands only a few feet above the streams, and a large proportion of it is flooded from time to time. Owing to the loose, porous structure of both soil and subsoil drainage is inclined to be excessive, although in local areas the water table stands during the winter months less than 6 feet below the surface.

This soil type is unimportant. A small acreage of alfalfa is being irrigated, but it requires a great deal of water and the yields are only moderate. Grain hay is produced in a small way without irrigation, with yields of about 1 ton per acre.

The Hanford coarse sand has a low agricultural value. Although it lies favorably for irrigation and a water supply is easily obtainable, its moisture requirements are so high that it is found to be more profitable to convey the water to more productive soils. It supports a variety of grasses and has some value for pasture.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Hanford coarse sand:

Mechanical analyses of Hanford coarse sand.¹

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|---------|---------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| | | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> |
| 575529 | Soil, 0 to 12 inches..... | 28.0 | 23.8 | 20.5 | 17.6 | 6.5 | 1.3 | 2.2 |
| 575530 | Subsoil, 12 to 72 inches. | 52.0 | 37.6 | 9.0 | .9 | .1 | .2 | .2 |

¹ Analysis by Division of Soil Technology, University of California.

HANFORD VERY FINE SAND.

Typically the surface soil of the Hanford very fine sand consists of 12 to 15 inches of brown to light-brown friable, micaceous very fine sand. As mapped, however, it includes some materials of darker brown color which approach in character soils of the Foster series. It contains a fair amount of organic matter and the surface is moderately firm. Owing to the large content of finely divided mica, it has a smooth, greasy feel, which gives it the appearance of being heavier in texture than the mechanical analysis indicates. The subsoil lacks uniformity. Typically it is a light-brown to grayish-brown, friable, micaceous very fine sand, to a depth of 6 feet or more but as parts of the type represent old river channels that have been filled with alluvial sediments there is great variation in texture and profile in the subsoil within short distances. As a rule, it is most uniform in areas farthest from the streams. In places, as along the west side of the Mohave River southeast of Victorville, the subsoil is a grayish-brown to light-brown, smooth micaceous very fine sandy loam passing abruptly at depths of 30 inches or more into gray coarse sand. The coarse material is loose and porous and usually contains a quantity of fine gravel. In the same locality are narrow strips in which the upper subsoil is mottled brown and gray and marked with iron stains.

This type of soil is confined to the Mohave River bottoms, where it occurs in narrow strips considerably broken by small bodies of the other types of the Hanford and Foster series. The most important bodies lie near Victorville and 2 to 6 miles southeast of that town. Narrow strips are developed also along the outer margin of the valley between that town and Oro Grande.

The surface of this type of soil is generally flat, although old drainage channels cross it at intervals. Near the river and in areas underlain by coarse porous sand, both surface and underdrainage are excellent, and in such areas there are no indications of alkali accumulation. However, most of the areas bordering the bluffs are slightly lower than the lands along the river and in places the seepage from near-by springs has water-logged the soil; here alkali also is likely to be present. Alkali is also found in places where the water table stands 3 to 5 feet below the surface.

The Hanford very fine sand is an important soil. A large proportion of it is under cultivation, and the rest supports a vigorous growth of sagebrush, cottonwood, and grasses. A number of small

fields formerly cultivated have been somewhat damaged by alkali and are now utilized for pasture. The principal crops are alfalfa and barley and wheat hay. Small acreages are devoted to potatoes, corn, and beans. Sugar beets were formerly grown, but the yields are said to have been unsatisfactory and the crop is not grown at present. Dairying also was at one time of considerable importance on this type of soil, but this industry has declined greatly. The type still supports a number of cattle and horses.

Alfalfa is usually cut four times each season, with yields of 1 to 1½ tons at each cutting. Grain hay yields 2 to 4 tons, with an average of about 2½ tons per acre. Potatoes return 250 to as much as 400 bushels, with an average of about 300 bushels per acre. These yields are, of course, obtained with irrigation.

In growing alfalfa the crop is irrigated twice between cuttings, the first irrigation being given in March. In favorable seasons the first cutting is made in April, but more frequently not until May, owing to retardation of the growth by late frosts. In some cases the fields are thoroughly harrowed with a spring-tooth harrow early in the spring to loosen the soil and destroy weeds. The grain hay crops are sown either in the fall and harvested in late spring, or are seeded in the spring and grown as an early summer crop. Frequently wheat or barley for hay occupies the same piece of land year after year. The small grains are commonly used as nurse crops in getting a stand of alfalfa.

This type of soil is valued at \$100 to \$150 an acre for undeveloped tracts, and about \$400 an acre for improved land under irrigation.

The Hanford very fine sand is considered one of the best soils in the Victorville area. It is an excellent soil for the production of alfalfa, potatoes, and grain hay crops. Owing to its low position along the river, crops are more likely to suffer from late spring frosts than on the higher mesa soils, and the type is therefore not so well adapted to the production of fruits. Its low position, however, has its advantages, as water for irrigation can be obtained from flowing wells or from wells in which the water stands comparatively near the surface. The soil is easily cultivated and responds readily to good treatment. It would be benefited by the addition of organic matter. Where the water table is high and alkali is beginning to show, it can be improved by artificial drainage.

The following table gives the results of mechanical analyses of samples of the Hanford very fine sand:

Mechanical analyses of Hanford very fine sand.¹

| Num- ber. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|--------------|---------------------------------------|------------------|------------------|------------------|------------------|--------------------|------------------|------------------|
| | | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> |
| 575504 | Soil 0 to 12 inches..... | 1.3 | 1.6 | 4.2 | 40.0 | 46.8 | 4.0 | 2.5 |
| 575505 | Subsoil 12 to 60 inches. | .0 | .4 | 2.8 | 61.8 | 31.0 | 2.4 | 2.2 |
| 575506 | Lower subsoil 60 to 72 inches..... | .6 | .8 | 2.1 | 44.5 | 40.6 | 7.0 | 3.6 |

¹ Analysis by Division of Soil Technology, University of California.

FOSTER FINE SAND.

The surface soil of the Foster fine sand consists of a dark grayish brown to dark-brown, friable, micaceous fine sand with an average depth of about 12 inches. When dry the soil is rather loose, but it contains a fair supply of organic matter and much mica, which give it a certain degree of coherency. The subsoil is of similar or somewhat lighter color than the surface soil, and may extend to a depth of 6 feet or more without important change, either in color or texture. It may, however, become still lighter colored and coarser textured in the lower depth. Typically it consists of light-brown to dull grayish brown friable fine sand or fine sandy loam containing a large percentage of mica. Locally it consists of various strata of light-textured materials, rarely heavier than fine sandy loam. In places beds of coarse stream gravel appear between 4 and 6 feet below the surface. In some areas both the surface soil and subsoil are somewhat mottled with reddish-brown iron stains. Near bodies of light-textured soils the surface is frequently covered with a thin deposit of loose, light-colored, medium sand. These areas really represent areas of soils of the Hanford series, but are too small to be mapped separately.

The Foster fine sand is confined to small areas along the Mohave River. It frequently occurs in very narrow strips adjacent to the bluffs and separated from the river by areas of Riverwash or other coarse material. The most important areas lie 1 to 6 miles southeast of Victorville. Other important areas occur just across the river from Victorville and at Oro Grande and between these towns.

The surface is uniformly smooth and nearly level except where traversed by abandoned drainage ways. The type varies in elevation from near the stream level to about 10 feet above. Following heavy rains in the mountains the lower areas are sometimes flooded for short periods, but such overflows are rare and do little harm. Although this type of soil has been developed under poorer conditions of drainage than the lighter colored soils of the Hanford series, the greater part of it at the present time is well drained. Locally small areas have a high water table, which has caused the accumulation of alkali in injurious quantities. The affected areas, however, constitute but a small part of the total area of the type.

Although the Foster fine sand is of small extent, it forms a considerable proportion of the lands of the area now being irrigated. About 75 per cent of it is under irrigation, or supports a good growth of grasses supplying valuable pasturage. The rest is covered with a mixed growth of sagebrush, cottonwood trees, and grasses and is used to some extent for grazing. The principal crops are alfalfa and grain hay, the former occupying somewhat the larger acreage. There are a few old fruit trees, mainly apples, on this soil near Oro Grande.

Alfalfa is cut on an average four times each season, the number of cuttings depending on the occurrence of the last killing frost in spring and the first in fall. The yields range from a little less than 1 ton to 1½ tons per acre per cutting. Barley or wheat hay yields 2 to 3½ tons, with an average of about 2½ tons per acre. This type of soil is farmed only with irrigation. The water is obtained either from flowing wells, or wells in which the water stands only a few feet below the surface.

Improved land of Foster fine sand under irrigation is held at \$200 to \$300 an acre, and unimproved land at \$100 to \$150 an acre, depending on the distance from Victorville.

The Foster fine sand is one of the most productive soils in the area. It is especially well adapted to the production of alfalfa and grain hay. Its adaptability, however, covers a wide range of crops, including potatoes, beans, root crops, and most of the fruits. Owing to its lower position, it is somewhat more subject to late spring and early frosts than the soils on the mesas. It has a good water supply from shallow wells, is permeable, friable, and easily cultivated. The soil in some areas of relatively light texture has a tendency to drift. This can be remedied by plowing under green-manure crops. Drainage is needed in a few small areas, and in most cases a more efficient use of water can be had by better leveling.

The following table gives the results of mechanical analyses of samples of the soil, subsurface, and subsoil of the Foster fine sand:

Mechanical analyses of Foster fine sand.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|---------|----------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| | | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> |
| 575501 | Soil, 0 to 12 inches.... | 0.6 | 8.1 | 11.2 | 50.4 | 17.8 | 9.7 | 2.1 |
| 575502 | Subsurface, 12 to 36 inches..... | 3.4 | 9.6 | 5.7 | 37.1 | 23.3 | 15.2 | 5.9 |
| 575503 | Subsoil, 36 to 72 inches..... | 5.0 | 15.9 | 9.8 | 37.7 | 15.1 | 11.7 | 4.8 |

FOSTER SILT LOAM.

The surface soil of the Foster silt loam consists of about 12 inches of dark grayish brown to dark-brown, smooth, micaceous silt loam. It contains considerable organic matter and, having very little sand, it is slightly plastic when moist. The subsoil is irregularly stratified and usually is of heavier texture than the surface soil. It generally consists of a dark grayish brown to dark-brown, smooth, micaceous silty loam of rather compact, yet permeable structure, overlying at depths of 2 to 3 feet alternating layers of silt loam and clay loam of the same general color. Where the type occupies old filled-in channels, as is the case in small strips southeast of Victorville, the soil overlies coarse sand and gravel at depths of 3 to 6 feet. In this same vicinity there are narrow strips in which the surface soil is very high in organic matter, approaching muck.

The Foster silt loam is of very small extent, being confined to small areas in the lowlands along the Mohave River. The largest area is a strip about 2 miles long and averaging less than one-fourth mile wide, lying some 3 miles southeast of Victorville. Another narrow, poorly drained strip, shown on the map with marsh symbols, occurs in the same locality. Two other very small bodies are mapped 1 to 3 miles northwest of Victorville.

This type of soil is usually found in low, flat areas bordering the bluffs, and in places drainage is poorly developed. Although alkali is present in small patches, it is not seriously affecting the greater part of the type. The small area shown on the map with marsh sym-

bols is perpetually water-logged by waste from artesian wells, and in its present condition is valueless.

A large proportion of this type of soil is irrigated and in alfalfa, the rest is covered with thick grasses and is used for pasture. About the same yields are obtained as on the Foster fine sand. It is handled in the same manner, has the same range in value, and is equally well adapted to a wide range of crops.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Foster silt loam:

Mechanical analyses of Foster silt loam.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|---------|---------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| | | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> |
| 575570 | Soil, 0 to 12 inches.... | 0.7 | 1.7 | 0.9 | 7.4 | 18.1 | 54.6 | 16.6 |
| 575571 | Subsoil, 12 to 36 inches. | .2 | 1.1 | .9 | 7.6 | 19.9 | 57.0 | 13.1 |

CAJON COARSE SAND.

The surface soil of the Cajon coarse sand consists of a light grayish brown or light-brown loose coarse sand overlying light-brown coarse sand of slightly more loamy character, extending to 20 inches. From 20 to 36 inches the material shows little change in texture but at a depth of about 36 inches it grades into light-brown, loose coarse sand and fine gravel. The soil is coarsest in the vicinity of stream channels, where it includes narrow strips of gravelly coarse sand, not of sufficient importance to be mapped. In unstirred areas the surface is firm, and shows little modification by winds. The soil is easily tilled, but the entire 6-foot profile is porous and leachy and, except in the most favorable localities, is unable to store sufficient moisture for the profitable production of dry-farmed crops. In places the type is almost entirely devoid of organic matter.

The total area of the Cajon coarse sand is small. It is confined principally to the narrow washes traversing the uplands, and is widely distributed. The largest single area occupies a recent alluvial fan leading up to the foothills of the San Bernardino Mountains, near the southeast corner of the survey. The lower part of this area is stony and is shown on the map by stone symbols. Narrow strips of this soil are found in nearly all of the dry washes south and west of Hesperia. It is usually confined to the lowest part of the washes and is traversed by the beds of dry streams. Irregular stratification fixes the origin of the material as alluvial (Pl. XXII, fig. 2). It has a gently sloping surface, and is well to excessively drained, though subject to occasional overflow along the stream channels, at which times fresh coarse soil materials are deposited.

This type has little agricultural importance. With the exception of a few small patches dry farmed to grain hay, none of it is being cultivated. The yield of hay averages less than 1 ton per acre. Sagebrush constitutes the principal vegetation on the higher elevations, and creosote bush and other desert shrubs occupy the lower areas.

This type of soil, in connection with other adjoining types, is said to be valued at \$10 to \$15 an acre. It is poorly adapted to dry farming, and water for irrigation is not available.

Cajon coarse sand, loamy phase.—The loamy phase of the Cajon coarse sand differs from the typical soil in its higher content of organic matter, darker color, and slightly heavier texture. The surface soil consists of about 14 inches of light-brown to brown, loamy coarse sand, containing in many places numerous small particles of granitic rock. The subsoil consists of light-brown coarse sandy loam, which may extend to a depth of 6 feet or more, or may pass at about 5 feet into brown, or reddish-brown, compact coarse sand. In places the phase includes small areas of coarse sandy loam and sandy loam. The surface is a little more firm, and the entire soil profile is a little more compact than the typical soil, thus causing it to have a somewhat greater capacity for the storage of water.

The loamy phase is of relatively small extent, although occupying an area but little smaller than the typical Cajon coarse sand. The two are closely associated, occurring in the same narrow washes south and west of Hesperia. The surface is smooth, with a gentle slope down the valleys and also toward the streams. Surface drainage and underdrainage are thorough. Both the surface soil and subsoil are sufficiently open to absorb water readily. The areas lying at the higher elevation seem a little more loamy and more retentive of moisture than those in lower positions.

This phase is of little importance. Probably less than 10 per cent of it is cultivated, most of the rest being covered with sagebrush, giant yucca, and other desert shrubs. Bunch grass and weeds occupy the high alluvial fan slopes and the upper parts of the draws and provide a small amount of pasture. About the only crops grown are wheat and barley for hay, the yields averaging about 1 ton per acre. None of the phase is under irrigation, the cultivated fields being confined to the higher elevations where rainfall is somewhat greater than on the open desert.

This phase is held at the same price as the typical Cajon coarse sand, but is slightly better adapted to dry-farm crops. It is confined to narrow strips broken by dry stream beds. At best only very small yields can be obtained, and even in seasons of favorable rainfall the margin of profit is small and dry-farmed crops can not be considered a commercial success. Stockmen, however, should find the phase of some value in the production of grain hay and other forage crops for use in supplementing the feed on the range. Under irrigation the soil should be adapted to a wide range of crops, but the possibility of developing sufficient water for this purpose seems remote.

Cajon coarse sand, dark-colored phase.—The surface soil of the Cajon coarse sand, dark-colored phase, is a dark-gray moderately compact sand of fine to medium texture, with a depth of 18 inches. Typically the surface is covered with a thin deposit of dark-gray, loose, coarse sand containing a quantity of dark-colored mineral particles, in which hornblende and mica are prominent. The subsoil is stratified and quite irregular in texture. In places it consists of gray or dark-gray, micaceous, fine sandy loam to a depth of 6 or more feet. In other localities the upper subsoil is a gray, compact sandy loam to a depth of about 26 inches where it grades into gray, compact,

very fine sandy loam containing a large percentage of mica, and this in places at an average depth of about 4 feet passes into brownish-gray silt loam slightly more compact than the overlying material.

It is recognized that this material represents a soil of a series distinct from the Cajon, but its small extent in the present survey did not seem to warrant separate mapping. It is distinguishable from the typical Cajon by its darker color, but it includes light-brown variations which merge with the typical Cajon soils. In color it is more nearly like the Foster soils, but is derived from dark-colored micaceous schists and similar rocks, the soil color being inherited from the parent materials, while in the Foster soils it has developed mainly through accumulation of organic matter under conditions of restricted drainage.

Cajon coarse sand, dark-colored phase, is confined to the northwest corner of T. 5 N., R. 6 W. It occupies strips along dry water courses. In general the topography is smooth, with a gentle, uniform slope toward the north. A number of dry water courses cross the phase and locally the surface is slightly modified by winds. Both surface drainage and underdrainage are well developed and there is no indication of accumulations of alkali.

In its present condition the phase has no agricultural importance. Practically all of it is covered with a growth of creosote bush, rabbit brush, and other desert plants. A scattering growth of bunch grass affords a small amount of grazing.

This soil is said to be valued at \$10 to \$15 an acre. It is quite retentive of moisture, but the light rainfall prohibits successful dry farming, and at present water for irrigation is not available.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Cajon coarse sand:

Mechanical analyses of Cajon coarse sand.¹

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|---------|-------------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| | | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> |
| 575531 | Soil, 0 to 20 inches.... | 30.9 | 21.4 | 13.8 | 11.2 | 9.4 | 7.8 | 4.0 |
| 575532 | Subsoil, 20 to 36 inches. | 24.4 | 19.8 | 15.6 | 13.4 | 12.0 | 7.2 | 6.5 |
| 575533 | Lower subsoil, 36 to 72 inches..... | 26.8 | 24.0 | 21.0 | 14.0 | 4.9 | 3.1 | 4.4 |

¹ Analysis by Division of Soil Technology, University of California.

CAJON LOAMY FINE SAND.

The surface soil of the Cajon loamy fine sand is a light grayish brown to light-brown loamy fine sand with an average depth of about 15 inches. The subsoil is a sand or sandy loam of moderately compact structure to an average depth of about 36 inches, where it grades into grayish-brown, loose, friable, loamy sand or sand.

This type shows considerable variation. It has been modified by winds, and occurring in very narrow washes, it frequently includes color and textural variations within short distances. Locally it consists of gray, loose, fine sand; in other places it approaches a fine sandy

loam in texture. It is lighter colored, more calcareous, and contains less organic matter on the open desert than on the higher elevations in the southern part of the area surveyed.

The Cajon loamy fine sand is not extensive. It is confined mainly to Baldy Mesa and the region west of Victorville, where it occurs in dry desert washes ranging from less than one-eighth to one-fourth mile in width. The bodies in the extreme western part of the area surveyed have a uniform and gently sloping surface and occur on the desert floor at practically the same elevation as the adjoining Hesperia sand. Elsewhere the type occupies narrow, sloping valleys through which meander the dry channels of desert streams. In one small area northwest of Victorville, where springs have kept the soil water-logged, there is a high concentration of alkali on the surface. Except in this area the soil has excellent drainage and is free from alkali in injurious quantities.

The Cajon loamy fine sand is of little present agricultural importance, as not more than 1 per cent of it is cultivated. In the lower desert areas the principal vegetation is creosote bush, rabbit brush, and giant yucca; at higher elevations there is a good growth of sagebrush, juniper, scrub oak, chamisal, and some grasses and weeds. The type is used principally for grazing. A small acreage of corn, barley, and wheat for hay and garden crops is grown for home use only, there being no fields large enough to produce crops for sale. In favorable seasons corn yields 20 to 25 bushels per acre. Barley and wheat hay yields from three-fourths to 1 ton per acre. These yields are obtained without irrigation in what are termed the "gulches," in the southern part of the area, where the elevation is around 4,000 feet. Here farmers state that as much as 25 inches of rainfall occurs in the more favorable seasons. However, a number of consecutive years may pass without water running in any of the drainage ways. The principal variety of corn grown is the Mexican June corn, an early ripening variety. This is ordinarily planted about May 1. At these high elevations the seasons are short and only early ripening varieties are successful.

This type of soil, in connection with adjoining rougher areas, can be bought for \$6 to \$15 an acre.

The high narrow valleys appear favorable for dry farming, although the areas are too small to justify their development except for the purpose of growing grain hay or other forage crops as an adjunct to stock raising. The desert areas are unsuited to dry farming, and at present there is little prospect of obtaining water for their irrigation.

The following table gives the results of mechanical analyses of samples of the soil, subsurface, and subsoil of the Cajon loamy fine sand:

Mechanical analyses of Cajon loamy fine sand.

| Number. | Description. | Fine gravel. | Coarse sand. | Medium sand. | Fine sand. | Very fine sand. | Silt. | Clay. |
|---------|-----------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| | | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> | <i>Per cent.</i> |
| 575511 | Soil, 0 to 15 inches.... | 2.6 | 7.1 | 5.6 | 39.5 | 24.8 | 13.1 | 7.0 |
| 575513 | Subsurface, 15 to 36 inches | 8.3 | 18.0 | 10.7 | 34.9 | 17.8 | 5.9 | 4.3 |
| 575512 | Subsoil, 36 to 72 inches. | 12.2 | 25.4 | 11.8 | 28.9 | 12.9 | 5.1 | 3.7 |

DUNESAND.

Dunesand as occurring in this survey consists of light-gray or brownish-gray, loose, incoherent, micaceous sand usually extending to a depth of 6 feet or more without material change. When moist the soil is light grayish brown, but dry surfaces appear light gray. Locally the subsoil is somewhat lighter colored than the surface material. The soil is composed of clean, sharp, granitic grains of fine to medium texture and, being almost entirely devoid of organic matter, is easily drifted by winds.

This type of soil material is one of the least extensive mapped. It occurs as narrow, dunelike ridges extending in a general north and south direction throughout the areas of Hanford coarse sand in the upper part of the Mohave River Valley. The ridges are rarely more than 10 feet above the adjacent parts of the valley and the surface is smoothly rolling. The type has excellent natural drainage, and the porous structure enables it to absorb water readily. It is also retentive of moisture, and since capillarity is poor, little water is lost by evaporation, and the entire soil section remains moist during the greater part of the year.

The type is agriculturally unimportant. The greater part of it supports a thick growth of giant yucca, desert shrubs, and a few weeds and grasses which are used for pasture. None of it is cultivated and the material is inferior to the associated soils for agricultural purposes, but with an adequate supply of water for irrigation it could probably be leveled and utilized for the production of alfalfa and certain fruits, among them peaches, berries, and grapes.

RIVERWASH.

Riverwash includes alluvial deposits of coarse and fine sand and gravel occurring in the channel of the Mohave River and along abandoned drainage ways. All the areas are subject to overflow, but except for short periods following rains much of the river bed is dry. The areas in old abandoned channels support a fair growth of cottonwood, willow, and grasses; those in the present river bed are barren.

Riverwash is confined to the first bottoms along the Mohave River where, excepting the short breaks at the Upper and Lower Narrows, it forms an almost continuous strip one-fourth to one-half mile wide across the area. A small part of it is used for pasture, but the greater part of it has no agricultural value.

ROUGH BROKEN LAND.

Rough broken land includes areas too steep or uneven for cultivation. It differs from Rough stony land in the absence of rock outcrop and in having a much deeper soil material. The type includes materials representing nearly all of the upland soils of the area.

The area of Rough broken land is extensive. It is mapped along the south side of the area and on the steep escarpments bordering the river valley. The largest area lies on the northern slope of the San Bernardino Mountains in the southern part of the area. Aside from areas of Rough stony land and of materials occupying the narrow floors of gulches leading from the mountains to the desert, the

type is nearly continuous along the south side of the area. Most of the ravines and canyons crossing the higher fans are bordered by narrow strips of rough topography which are included with this type. An extensive area, averaging about three-fourths mile in width, extends north along the west side of the Mohave River Valley from a point south of Victorville to beyond the limits of the area.

Rough broken land is nonagricultural, but includes locally very small patches of arable land. The higher areas support a dense growth of oak brush and chamisal, with an undergrowth of weeds and grasses that supply grazing. Except for a scattering growth of creosote bush, the desert areas are nearly barren of vegetation.

ROUGH STONY LAND.

Rough stony land consists of rugged, mountainous areas in which the topography is too steep and the soil too stony for cultivation. A large proportion of the type in this area consists of rock outcrop which rises abruptly in islandlike masses several hundred feet above the surrounding plains. The rock is mainly granite. The rougher areas have very little soil material and are practically bare of vegetation.

Although the greater part of the soil material of Rough stony land is of residual origin, the foothill slopes adjoining Oro Grande consist of stony old valley-filling deposits which have been partly consolidated. In places these deposits are many feet in depth, while in others they constitute only a shallow covering over the underlying rock. The surface of this area is somewhat smoother than the areas of rock outcrop, but the greater part of it is that of steep alluvial fans which are more or less eroded by steep-sided drainage courses.

Rough stony land as a whole is nonagricultural. A few small patches of tillable land are included, but are too small to warrant irrigation and are not suited to dry farming. Such areas support a growth of creosote bush and other desert shrubs, but have little value for grazing.

IRRIGATION.

Much of the data used in this chapter regarding wells, stream discharge, character of drainage basin, duty of water, and extent of irrigation development, etc., is taken from a report⁸ on irrigation in Victor Valley, and the reader is referred to this work for further information and a more detailed treatment of the subject.

Although irrigation has been practiced in the Victorville area for more than 50 years, little recent progress has been made and the irrigated acreage is still comparatively small. According to the authority cited, the total area irrigated in Victor Valley, including the lands in Lucerne Valley Pass and Mirage Valley, which lie beyond the limits of the survey, is 7,740 acres. Of this 5,555 acres lie in the bottoms of the Mohave River and on the first bench of the east mesa. An area of 975 acres is on the east mesa and in the Lucerne Valley Pass, just east of the area surveyed, while 1,210 acres are on the west

⁸ Bulletin 5, Report on the Utilization of the Mohave River for Irrigation in Victor Valley, California, by the Department of Engineering, of the State of California.

mesa and in Mirage Valley to the west. Aside from springs, which irrigate a small acreage near Victorville, there are two sources of water for irrigation in this area, the Mohave River and wells. Of these the river is of much the greater importance, although at the present time less than 2,000 acres are being watered from this source. About 5,000 acres are irrigated from wells. One reason for the small acreage irrigated from the river is the intermittent character of the stream. Although the river flows continuously through the Upper Narrows at Victorville and at the Lower Narrows 4 miles below, the flow sinks in the sandy channel a short distance below the Forks at the junction of the West Fork and Deep Creek, about three-fourths mile outside the southern boundary of the survey, and during the greater part of the year the channel is a dry sandy bed. According to measurements taken at the Forks and at the Upper Narrows from 1906-7 to 1913-14, inclusive, the average seasonal discharge at these two points is 112,128 and 117,393 acre-feet, respectively. For the period from 1897 to 1915, inclusive, the annual discharge of the river at the Forks is estimated to have been approximately 90,000 acre-feet. During the latter part of summer the volume is very much reduced, the measurements for September, 1905, at this point showing only 43 acre-feet, although at the Upper Narrows the flow for this month was 2,380 acre-feet. Since much of the river between these points is dry the greater part of the year, the early settlers established their ditches either near the Narrows or just below the Forks, or where the flow of the river was constant. It is said that all of the ditches now diverting at favorable locations were constructed prior to 1886 and those established since that are flood-water ditches, which receive water only during the early part of the irrigating season. Thus the only means of increasing the irrigated acreage from this source is by constructing storage reservoirs.

At the present time the greater part of the irrigated acreage is being served by wells. The report already cited makes the following statement in regard to wells in the Victorville area and that part of the desert immediately adjoining:

The total number of wells, between the mountains on the south and the north line of township 6 on the north and between Lucerne Valley on the east and Los Angeles County line on the west, is 333. Of these 214 are drilled and steel-cased and the remainder are dug shafts. A total of 125 wells, the most of which are drilled, are equipped with pumping machinery, the power being gasoline or oil engines with but four exceptions, and 43 wells are pumped with windmills. Although the main transmission line of the Southern Sierras Power Company crosses Victor Valley, electric power is not distributed generally to pumping plants. Thirteen wells, all located in the river bottoms just above the Upper Narrows on Rancho Verde, flow.

An abundance of ground water and low lifts make pumping economical and efficient in the river bottom and on the first bench of east mesa. This area embraces 48 pumping plants, the most of which have lifts ranging from 50 to 100 feet and discharges from 50 to 200 miner's inches.

The second or main bench of the east mesa, including the pass east of Deadman Point, has 31 pumping plants. The highest discharge for any of these is 70 miner's inches and the most are under 50 miner's inches. Excluding the plants in the pass the lifts range from 72 to 242 feet.

The west mesa includes 40 pumping plants. The lift at Hesperia is 300 feet and at one well on Baldy Mesa it is 869 feet. Such lifts are economically prohibitive for this region and but small streams of water have been pumped from these wells. The lifts are lower and the wells better near the settlement of Adelanto in Sunrise Valley and still better conditions for pumping are found in Mirage Valley. The depth to

water is only about 20 feet in wells near the dry lake bed and some good producing wells are located there.

Excluding the river bottom and first bench and considering the mesa lands, it appears that the only sections in which pumping underground water can be relied upon as the sole source of supply to irrigate large solid areas are the north central portion of the east mesa, the lower portion of Mirage Valley, and possibly that in the vicinity of Adelanto. A great majority of the west mesa and a portion of the east mesa can be reclaimed only by stream flood waters, stored and conveyed by gravity.

About one-half million dollars has been invested in wells and pumping machinery in Victor Valley.

According to the same authority, the original cost of completely equipped wells in Victor Valley ranges between \$4,500 and \$6,000 or more per well. In the Mohave River bottoms, where the wells are comparatively shallow and good producers, the pumping lifts low, and the soil sandy, it was found that the cost of irrigating alfalfa was around \$13.40 an acre per annum. In this case a total of 5 acre-feet of water was applied. On the east mesa, where the wells are deeper, the lifts greater, the discharge less, the soils more compact, and the duty of water higher, the cost of irrigating apple orchards was \$11.27 per acre per annum. In this case only 1.5 acre-feet of water was applied. On the west mesa, where the wells are deep and the discharges small, the cost of pumping was found to be between \$16 to \$17 an acre. These figures do not include depreciation on well or building, nor do they include the expense of ditching and distributing the water over the fields.

A number of springs issue from the west bank of the Mohave River from a point 2 miles above to a point 4.5 miles below the Upper Narrows. None are found on the east side. Most of the springs are small and are of value only for domestic use, but there is one, the Turner Spring, about three-fourths mile below the Lower Narrows, that fills a small reservoir and is used to irrigate an alfalfa field of several acres.

The water from wells in Mohave Desert is said to be of good quality for irrigation, and that from the river is derived partly from snow and should be free from injurious alkali. The principal crops grown in this area are tree fruits, mainly apples, and alfalfa. The quantity of water applied varies considerably with the available supply and the character of the soil. In the sandy bottoms of the Mohave River as much as 16 acre-feet has been applied to alfalfa, according to the State engineering department. In one instance on the east mesa alfalfa received 6.89 acre-feet, while on the west mesa two tracts used 1.24 and 4.07 acre-feet, respectively. In the bottoms two selected tracts of deciduous fruits received an average of 2.39 acre-feet. On the east mesa 8 orchards were being given an average of 1.17 acre-feet, while some of the orchards of the west mesa were receiving as little as 0.22 acre-feet. The average for 11 orchards on the west mesa was only 0.49 acre-feet. This is somewhat less than is required in other sections of California where rainfall is equally scant and less than is used in sections of other States where rainfall is more favorable. Many of the trees in the Victorville area have made only an inferior growth, and most of the orchards appear to have received insufficient water for vigorous production. The quantity of water required for best results will vary somewhat with the character of the soil. Also, since the east mesa is lower and receives

less rainfall than the west mesa, it is probable that more water will be required in the former locality. The State engineering department recommends a duty of 1.25 acre-feet per acre for the west mesa, and 1.50 acre-feet per acre for the east mesa.

The irrigable land in Victor Valley exceeds the water supply. It is estimated that the agricultural area covers 325,000 acres within the area surveyed and the section immediately adjoining, while it has been shown that the average annual discharge of the river where it enters the area is approximately 90,000 acre-feet. Outside of the river bottoms and a few other favored localities, wells as a source of water for irrigation have not been satisfactory, as the water supply is small and the expense of pumping high. About one-half of those dug on the mesas have proven to be dry holes. It appears, therefore, that the most feasible way to increase the irrigated acreage is to construct reservoirs to impound the waters of the Mohave River. Such improvements are costly and only groups of individuals, such as irrigation districts, irrigation companies, or men of financial means can undertake them. In the past a number of companies have been organized for this purpose and some have made considerable progress in construction. In addition, two irrigation districts have been formed. The Mohave River Irrigation District embraces 27,655 acres on the east mesa, the greater part of which is irrigable, and the Victor Valley Irrigation District on the west mesa covers 71,517 acres, of which 65,000 are said to be irrigable. The course of procedure to be followed does not appear to be definitely decided upon, as with the shortage of water any course entered upon will entail eliminating a part of the lands that might otherwise be irrigated. Regardless of how this adjustment is made, the projects include the construction of reservoirs from which water will be conveyed to the lands by gravity and the development of electrical power for use in lifting the water onto the lands above the gravity ditches. Engineers have reported these projects feasible, and there are apparently no conditions of soil to impair their practicability.

ALKALI.

The Victorville area is comparatively free from inurious quantities of alkali. Salts in sufficient quantities to interfere with the growth of crops are confined to small spots in the bottoms of the Mohave River. The largest areas of alkali affected soils occur just above the Upper Narrows, 1 to 4 miles southeast of Victorville, and under the bluffs along the west side of the river about 2 miles south of Oro Grande. The total area seriously affected is less than 1 square mile. Of this only about 10 acres south of Oro Grande has been abandoned. In this locality most of the damage appears to have been caused by sodium carbonate, or black alkali. Examination of surface crusts shows that this form of alkali is present in considerable quantities, and the surface of affected spots has the characteristic black color that this salt produces. There is practically no indication of black alkali in the affected areas southeast of Victorville. In places white incrustations appear on the surface, but the greater part of the affected lands support a uniform growth of salt grass and other plants useful for pasture.

Alkali accumulations in the Victorville area are due in every case to poor drainage. Southeast of Victorville small areas have become water-logged by the uncontrolled runoff of flowing wells. At the time of the survey the water table in these areas was rarely more than 3 feet below the surface and stood at only 1 to 2 feet in some places. The area south of Oro Grande lies below a spring which keeps it in a water-logged condition the greater part of the year.

Both of these areas would be improved by artificial drainage, although their complete reclamation would be difficult because of their low position with respect to the river. The excess water should be diverted from the areas and only such amounts should be allowed to reach the land as are needed for plant growth.

A number of alkali determinations of each foot of soil to a depth of 6 feet were made on the various types of the uplands and the tests rarely showed the presence of more than a trace of salts. With water used sparingly, as will probably be done in case the lands are irrigated, it is believed little or no trouble will be experienced from accumulation of alkali in this area.

SUMMARY.

The Victorville area embraces 354 square miles, or 226,560 acres, in the southwestern part of San Bernardino County. It lies in the southern part of the Mohave Desert and is separated from the nearby lower lying citrus belt of southern California by the San Bernardino and San Gabriel Mountains.

The Mohave River, the only stream of importance in the area, crosses the region from south to north. It is intermittent, its waters sinking in the sandy channel throughout the greater part of its course. Excepting the mountain footslopes along the south side and a few scattering buttes, the area in general is smooth.

Victorville, with about 600 inhabitants, is the largest town in the area. Oro Grande, in the northern part, and Hesperia in the southern part, are smaller towns.

About one-third of the area is State school land, railroad grant lands, or holdings in the hands of corporations. A considerable acreage of corporation lands are under irrigation. Most of the public land suitable for agriculture has been taken up either as homesteads or desert claims. The greater part of the area is thinly settled and extensive tracts in various parts are uninhabited.

Transportation facilities are afforded by the Atchison, Topeka & Santa Fe Railway crossing the central part of the area from north to south. The tracks of this line are used also by the Union Pacific Railroad.

The climate is arid, the average seasonal rainfall varying from about 4.3 to 9 inches on the desert, and being about 15 inches near the foothills. The greater part of the rain falls during the winter, and during the rest of the year the precipitation is usually so small as to be of little benefit to crops. The winters are cold for this latitude, as the greater part of the area lies between 3,000 and 4,000 feet above sea level. The summers are hot, but owing to the low humidity the heat is not oppressive. The maximum temperature at Barstow is 114° F. and the minimum 12° F. Zero weather has been recorded

at Victorville. Little damage should be expected from frosts as the high altitude retards the development of fruit buds until after most of the danger is past.

Prior to 1912 the lands of the area were utilized almost entirely as a range for cattle. The herds were grazed on the open range and pastured on irrigated lands in the valley. About this time a large acreage of apples was planted which are now just beginning to bear. Dry farming is practiced only on the higher parts of Baldy Mesa. Grain hay is about the only crop produced. The yields are low and uncertain. With irrigation alfalfa averages about 5 tons per acre.

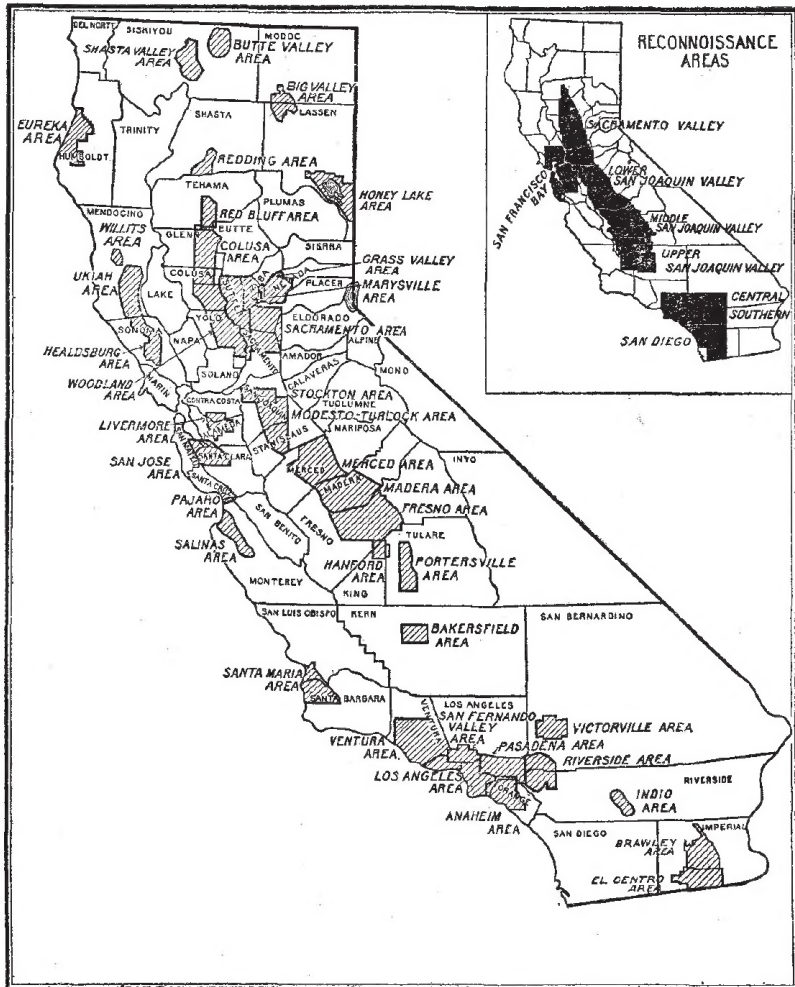
Most of the farms are 160 acres in size, although large tracts are owned by corporations. Unimproved lands sell at \$10 to \$40 an acre; irrigated orchards at \$100 to \$350 an acre.

The area is a structural basin which has been filled in to a depth of several hundred feet. The soils which are formed mainly of granitic material, range in color from grayish-brown to red. They may be grouped broadly into 7 series, which are represented by 20 types and a number of phases. The Mohave, Adelanto, Sunrise, and Hesperia series are upland soils derived from unconsolidated old valley-filling materials, and the Hanford, Foster, and Cajon occupy stream bottoms or recent alluvial fans.

A large proportion of the Victorville area is adapted to irrigation. There are two principal sources of water—the Mohave River and wells. The river is of the greater potential importance although up to the present time less than 2,000 acres have been irrigated from this source, while about 5,000 acres have been watered from wells. In many cases wells as a source of water for irrigation have been disappointing. Aside from the river bottoms and first bench, it is probable that the only sections in which pumping underground water can be relied upon as the sole source of supply are the north-central parts of the east mesa, and possibly the section in the vicinity of Adelanto.

Two irrigation districts have recently been formed for the purpose of constructing reservoirs in the Mohave watershed south of this area, and conveying the water to the lands of the area by gravity. Engineers have reported these projects feasible, and there are apparently no soil conditions to impair their practicability.





Areas surveyed in California, shown by shading.

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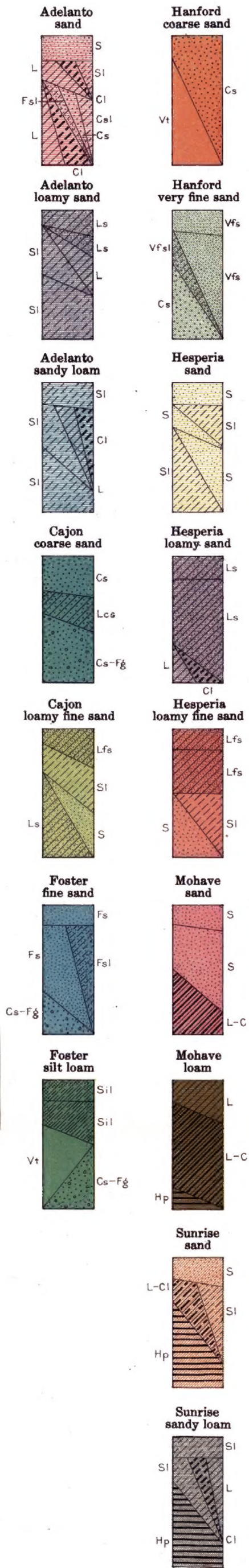
Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

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- (1) mail: U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;
- (2) fax: (202) 690-7442; or
- (3) email: program.intake@usda.gov.

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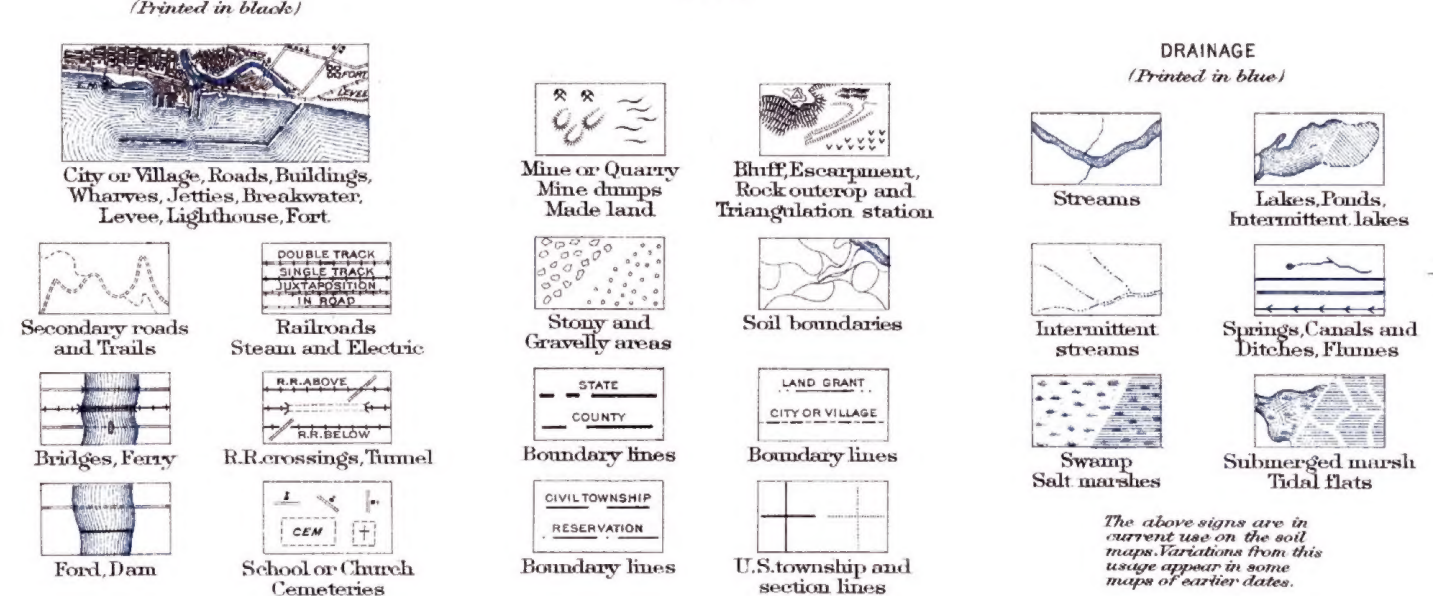
SOIL PROFILE
(6 feet deep)



LEGEND

Fg Fine gravel
Cs Coarse sand
S Sand
Fs Fine sand
Vfs Very fine sand
Lcs Loamy coarse sand
Ls Loamy sand
Lfs Loamy fine sand
Csl Coarse sandy loam
Sl Sandy loam
Fsl Fine sandy loam
Vfsl Very fine sandy loam
L Loam
Sll Silt loam
Cl Clay loam
Vt Strata of various textures
Hp Hardpan (calcareous)
L-C Loam to clay
L-CI Loam to clay loam
Cs-Fg Coarse sand to fine gravel

CONVENTIONAL
SIGNS



LEGEND

